This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

+ *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.

+ *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.

+ *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.

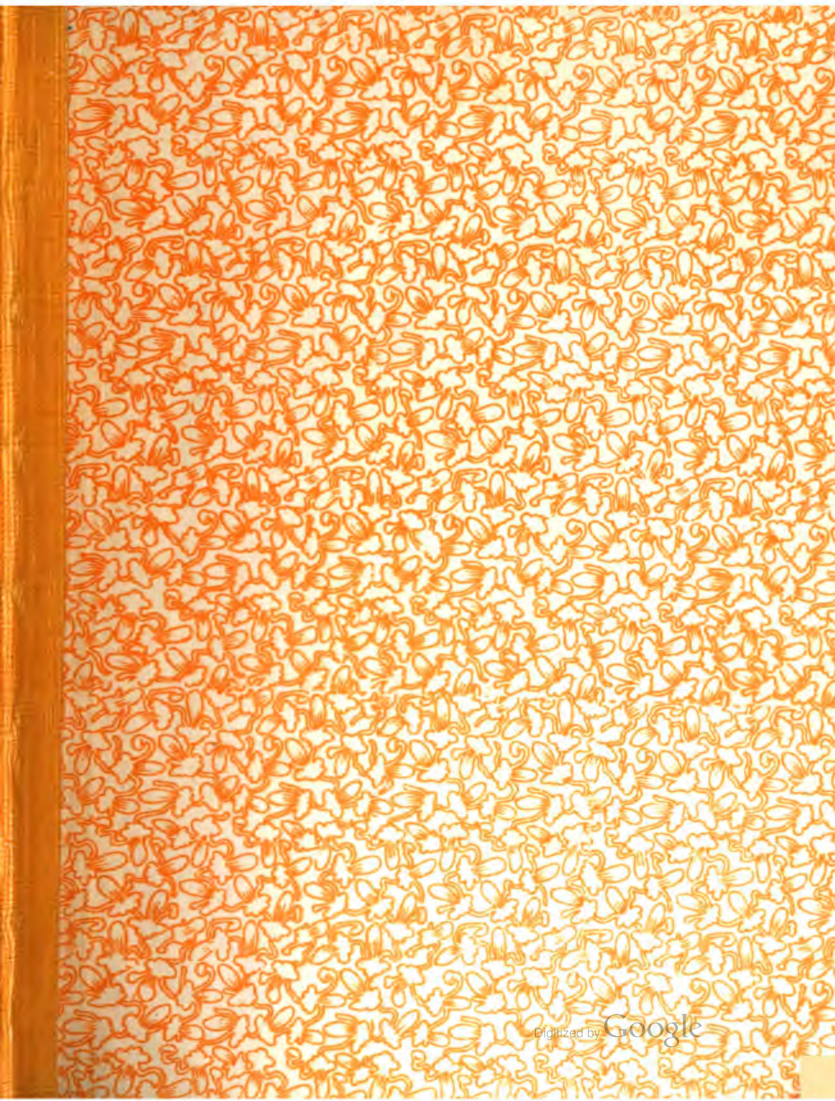
+ *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at `http://books.google.com/`

UC-NRLF
$B 261 935

SIGILLVM · VNIVERSITATIS · CALIFORNIENSIS
FIAT LVX
MDCCCLXVIII
EX LIBRIS



THIRD EDITION, REVISED

COAST ARTILLERY MATÉRIEL

DESCRIPTION, ADJUSTMENT, AND OPERATION IN DRILL AND TARGET PRACTICE

PREPARED ESPECIALLY FOR *OFFICERS* AND *ENLISTED MEN* OF THE *NATIONAL GUARD*, AND RECOMMENDED FOR THEIR USE BY THE *MILITIA BUREAU* OF THE *WAR DEPARTMENT*

BY

CAPTAIN W. P. PLATT

Coast Artillery Corps, U. S. Army;
Inspector-Instructor, California Coast Artillery.

Franklin Hudson Publishing Co.
KANSAS CITY, MO.

UF453
P5

Copyrighted 1917 by
Franklin Hudson Publishing Co.

Changes in "COAST ARTILLERY MATERIEL" (2nd Edition) occasioned by the new examination order, Circular No. 14, Militia Bureau, 1917, which replaces G. O. No. 2, 1916.

Basic Course:

Page 116 (114 for first edition).
Cross out subjects (*i*) and (*j*).
Page 120 (118 for first edition).
Cross out the questions under (*i*) and (*j*).

Emplacement Course:

Page 121 (119 for first edition).
Add new subjects:
Ammunition trucks and hoists.
Signals used at the emplacement.
Retracting gear.

Battery Commander Course:

Page 130 (128 for first edition).
Cross out subject (*g*).
Add new subjects:
Precautions for safety at the battery.
Electrical apparatus at the battery.
Page 134 (132 for first edition).
Cross out subject (*g*).

Staff Officer Course:

Page 134 (132 for first edition).
Add new subjects:
Power plant management.
A general knowledge of the light and power service of a fort.
Electrical apparatus installed in a fort command.
A general knowledge of the equipment, omitting submarine mine matériel.
A detailed knowledge of the use and care of telephones.

Fire and Fort Commander Course:

Page 137 (135 for first edition).
Cross out subject (*j*).
Add new subject:
Precautions for safety in general.

Note: The student will find it convenient to cut out the above subjects and paste them in his book in the places indicated.

359890

CONTENTS.

(Numbers refer to paragraphs.)

Page

ORGANIZATION AND COAST DEFENSE, Chapter I 5

General principles, 1. Forms of attack, 2. Armament, 3. Tactical organization, 4. Assignment of personnel, 5. Manning tables, 6 and 7.

GUNNERY AND BALLISTICS, Chapter II 11

Pointing devices, 8. Pointing methods, 9. Pointing and prediction tests, 10. Deviations, 11. Errors, 12. Range board corrections (guns), 13. Corrections for trial shots, 14. Formula and correction for danger space, 15 and 16.

AMMUNITION, Chapter III 21

Fuses, 17. Primers, 18. Powders, 19. Powder blending, 20. Care and storage of explosives, 21. Projectiles, 22. Filling and fusing projectiles, 23. Pressure gauges, 24.

GUNS AND CARRIAGES, Chapter IV 29

Types of cannon, 25. Gas check pad, 26. Dismounting and dismantling breech mechanism, 27 and 28. Firing mechanism, 29. Types of carriages, 30 and 31. Adjustment of sight standard and azimuth subscale, 32. Adjustment of range scale and quadrant, 23. Elevating friction mechanism, 34. Dismounting mortars, 35. Cleaning recoil cylinders, 36. Grease cups, 37. Recoil system and valves, 38. Stuffing boxes, 39. Care of matériel, 40.

FIRE CONTROL APPARATUS, Chapter V 39

Anemometer, 41. Atmosphere and powder rule, 42. Barometer, 43. Communications and fire control equipment, 44. Deflection board, gun, 45. Deflection board, mortar, 46. Deflection recorder's board, 47. Indication and identification of targets, 48. Muzzle velocity chart, gun, 49. Muzzle velocity chart, mortar, 50. Mortar elevation board, 51. Plotting board, gun and mortar, 52. Plotting-board, fire commander, 53. Plotting board, 360°, 54. Plotting room duties, gun and mortar, 55 and 56. Position finding instruments, 57. Lewis D. P. F., Model 1898, 58. Lewis D. P. F., Model 1907, 59. Swasey D. P. F., 60. W. & S. azimuth instruments, 61. Coincidence range finder, 62. Position finding systems, 63. Salvo points, 64. Prediction scale, 65. Predictor, 66. Range board, gun, Pratt, 67. Range board, gun, Model 1909, 68. Range board, mortar, Model 1914, 69. Set forward ruler, 70. Telephones, 71. Wind component indicator, 72. Wind vane, 73. Thermometer, 74. Tide indicator, 75. Time-interval system, 76. Time-range board, 77.

Page
DRILLS AND INSPECTIONS, Chapter VI.......................... 75
Formation of company, 78. Inspection in ranks, 79. Marching maneuvers, 80. Reports when manning stations and batteries, 81. Battery drill, 82. Inspection of battery, 83. Firing salutes, 84.
SEARCHLIGHTS AND SIGNALING, Chapter VII................ 81
Kinds of codes, 85. Shore tug signaling, 86. General service code, 87. International code, 88. Acetylene lantern, 89. Searchlights, 90. Searchlight commands, 91. Night drill, 92.
COMMANDS, Chapter VIII................................ 88
Complete list of, from cannoneer to fort commander, 93.
CORDAGE, Chapter IX.................................. 91
Material, 94. Knots and hitches, 95. Tackle, 96. Cranes, derricks, gins, and sheers, 97. Hydraulic jacks, 98.
WARSHIPS, Chapter X.................................. 95
Characteristics of all types, 99.
TARGET PRACTICE, Chapter XI........................... 99
Subcaliber practice, 100. Subcaliber guns, 101. Care of empty cartridge cases and primer bodies, 102. Service practice inspection, 103. Adjustment of matériel, 104. Kinds, 105. Use of pressure gauges, 106. Sight standard, 107. Obturator and safety firing device, 108. Elevating friction device, 109. Recoil system, 110. Firing of trial shots, 111. Correction for deflection, 112. Correction for range, 113. Location of splashes, record shots, 114 and 116. Targets, 115. Determination of hits, 117. Figure of merit, 118. Safety precautions, 119. Umpire, 120. Conduct of practice, 121. Target practice reports, 122. Data for reports, 123.
EXAMINATIONS FOR OFFICERS, Chapter XII................115
EXAMINATIONS FOR RATED POSITIONS, Chapter XIII........142
DRILL REGULATIONS, C. A., 1914, QUESTIONS, Chapter XIV...153
INDEX...174

PREFACE.

National Guard officers and enlisted men entering the Coast Artillery service are at a loss to determine how best, within their limited time, to properly equip themselves for this work. The mass of written matter and books to which they are referred is staggering.

Few of them can spare the time or have the opportunity to become experts; their aim would better be to become practical coast artillery men—*i. e.*, to acquire a working knowledge that will enable them to handle coast artillery matériel. With this in view, the author prepared this volume; it is believed to contain the meat of some fifteen or twenty books and pamphlets. The following subjects are treated: organization and coast defense; gunnery and ballistics; ammunition; guns and carriages; fire control apparatus; drills and inspections; searchlights and signaling; cordage; warships; and preparation for and conduct of target practice, and reports. The drill at the piece, for want of space, is omitted; it is suggested that the manual of drill desired be clipped from one of the various pamphlets and inserted, thus making this publication complete.

The lists of questions prepared cover in detail the entire subject matter referred to in G. O. No. 2, W. D., 1916, as well as to include those used in former examinations. The references, except for the drill, apply entirely to the text. This arrangement will serve not only as a quiz to those who have gone over the subject matter, but will be of considerable assistance in preparing for the examinations.

The publication is also recommended to junior officers and enlisted men of the regular service, particularly when entering the service or preparing for instructors of visiting militia troops during coast defense exercises.

The publication complies with the provisions of the Annual Instruction Order for Coast Artillery, 1916.

The author is indebted to the following officers for advice and helpful suggestions: Captain H. B. Clark and Captain J. B. Murphy, of the regular Coast Artillery Corps, and Lieut.-Col. H. G, Mathewson and Captain A. G. Wright, of the California Coast Artillery Corps. Colonel Mathewson's compilation of examination questions has been freely used.

The author is also indebted to Sergt. F. Lofquist, Coast Artillery Corps, U. S. Army, for suggestions and assistance in the preparation of the work.

Acknowledgment is due the authors of "Gunners' Instruction" and "Service of Coast Artillery" for the free use of those publications; the former is particularly useful to the beginner, while the latter furnishes considerable material for advance study.

San Francisco, Calif., W. P. Platt.
January 1st, 1916.

PREFACE TO SECOND EDITION.

Additional data on searchlights have been inserted; the change was suggested by Captain Niles in his instruction notes. No other material changes have been made in the text of the first edition, except those necessary to make the publication comply with the annual Instruction Order for Coast Artillery for 1917 and to embody the changes noted on the correction-sheet of the first edition. The lists of questions have been revised so as to include those used in the May and November, 1916, examinations. Several minor changes suggested by these questions have been incorporated in the text. An index has also been added.

Candidates when preparing for examinations are advised not to confine themselves to the lists of questions under a particular course, but to look through the lists under the same headings in other courses; additional ideas will be gotten in this way.

San Francisco, Calif., W. P. Platt.
December 1st, 1916.

CHAPTER I.

ORGANIZATION AND COAST DEFENSE.

1. The defense of a coast line devolves on:

(1) Coast artillery troops, regular or militia, provided for the maintenance and operation of the matériel (fixed and movable);

(2) Coast artillery supports, consisting of coast artillery or mobile troops assigned to the fortifications and operating against raiding parties;

(3) Coast guard, consisting of mobile troops operating against the enemy's mobile troops;

(4) Local naval forces and patrol boats, assigned for that purpose.

The military preparations by land forces for defense may be divided into:

(1) Constructing, arming, and equipping permanent fortifications and submarine defenses;

(2) Constructing, arming, and equipping field works for the protection of the forts against attack by raiding parties either on the landward or seaward side;

(3) The organization and mobilization of mobile troops to operate against and resist the landing of large bodies of troops, and for use in semi-permanent field works.

2. The forms of attack against a fortified harbor are:

(1) Land attack; this may take the form of small raids against searchlight or fire control stations, or it may be a general demonstration against the rear of a fort;

(2) Distant bombardment by capital ships;

(3) General attack by all naval forces;

(4) Reconnaissance in force to draw the fire of the fort, thereby exposing the location of the batteries;

(5) Raid by cruisers and destroyers on mine fields, searchlights, or observing stations;

(6) Run by.

Either form of attack from the sea may be accompanied by a land attack.

3. The movable armament comprises the field and siege matériel for use against landward and seaward forces.

The fixed armament consists of guns, mortars, and mines, the position-finding and power stations, communications, casemates, and other accessory matériel.

The fixed armament is classified into:

(1) Major caliber: 8-inch and larger guns, employing direct fire against the vertical armor of armored ships, and mortars employing high-angle fire against decks of warships;

(2) Intermediate caliber: 5-inch and 6-inch guns, employing direct fire against lighter armor of warships;

(3) Minor caliber: 3-inch and 4.7-inch guns, employing direct fire against unarmored ships, and to cover mine fields.

4. The units of the tactical chain of command are:

(1) **Battery command,** consisting of two or more guns or mortar pits with its fire-control equipment and personnel;

(2) **Fire command,** consisting of two or more batteries, fire-control equipment and personnel assigned to the fire command; guns and mortars are not generally grouped in the same fire command, nor are guns of lesser caliber grouped with the major caliber armament; only batteries covering the same field of fire should be grouped in one fire command;

(3) **Mine command,** consisting of such mine defense, including rapid-fire guns and personnel, as can be controlled by a single individual;

(4) **Support command,** consisting of the personnel and matériel of the coast artillery supports of a single fort;

(5) **Fort command,** consisting of all the means of seaward and landward defense, including personnel and matériel, at a single fort;

(6) **Coast defense command,** consisting of the several fort commands of a harbor. The senior coast artillery officer present for duty is the coast defense commander; the senior officer present in each of the other commands is its commander.

The C. A. non-commissioned staff is composed of sergeants-major senior and junior grades, master electricians, engineers, assistant engineers, electrician sergeants first and second class, master gunners, radio sergeants, and firemen. All except the sergeants-major are called "enlisted specialists." For appointment and promotion, see A. R. and G. O. 2 and 46, W. D., 1916.

The geographical limits and headquarters of coast artillery districts, the limits and headquarters of coast defense commands, and the commanders thereof, are established in War Department orders.

All officers in a coast defense are assigned to forts and tactical commands and duties by the coast defense commander. He also decides which elements of defense are to remain "in service" and assigns companies accordingly; all changes in assignment are promptly reported to the War Department.

5. The **coast defense commander** is responsible for the efficiency of his command, both from a tactical and administrative standpoint; he has as staff officers, (1) Coast Defense Adjutant; (2) Coast Defense Artillery Engineer, charged with the care and operation of power and communication systems; (3) Coast Defense Ordnance Officer, charged with the care of all armament and accessories except communications; (4) Coast Defense Quartermaster, charged with land and water transportation, quartermaster supplies funds and buildings. He should also prepare plans of defense to meet the various forms of attack; these plans are numbered or otherwise designated, and when ordered from the fort commander's station as "General Defense Plan No. 2," indicates at once what is to be done by all units.

The **fort commander** is responsible for all matters affecting the efficiency, instruction, discipline, and appearance of the personnel, and service and care of all matériel, landward and seaward, of his command. He is assisted by: (1) a "personnel officer," who, in action, has direct charge of all fire-control apparatus of the command, and transmits the orders of the fort commander; (2) a "matériel officer," who has charge of the communication and power service and armament of the fort, and is charged with its maintenance before and during drill. All defects are reported to the matériel officer, who will promptly have them corrected by his electricians or else reported to the proper staff officer. The matériel officer is also responsible for the instruction and drill of the searchlight manning parties.

In action the fort commander, from his station, controls the seaward defense through the fire and mine commanders, and the landward defense through the support commander. The seaward defense of two or more forts covering the same water area is controlled by the senior fort commander.

The complete control of fire or battery commands devolves on the commanders thereof when communication with the next high commander is interrupted, or at the command "Fire (or Battery) Commander's Action."

→ The **fire commander** is responsible for the tactical efficiency of his fire command, and is assisted by a communication officer (commissioned if available, otherwise a sergeant), who has charge of the communications and the fire command stations.

The **battery commander** keeps a record of daily attendance (by numbers), showing those at the battery and elsewhere. He is responsible for the drill and efficiency of his battery; for the care of matériel, and that no modifications are made without authority; for the tidy appearance of his men; and that the emplacement-book is kept in accordance with regulations. He should make every effort to keep supplied with the proper equipment and reserve ammunition. No modification in the drill nor use of any new device is allowed except by authority of the coast defense cammander, who may allow a trial made and report thereof to War Department. He should improvise a method of fire direction to be used in case the regular stations go out; in many cases range points and stakes can be used for both gun and mortar firing.

The **range officer** is stationed at the battery plotting room; he is in charge of the fire control apparatus and is responsible tc the battery commander for its condition, and for the efficiency of the range section.

The **emplacement (battery) officer** is in charge of one or more emplacements, and is responsible to the battery commander for the condition of the matériel at the battery, and for the efficiency of the gun or pit sections.

The **plotter** is in direct charge of the personnel, and is responsible for the condition and adjustment of the equipment in the plotting room.

Observers are in direct charge of the personnel, and responsible for the condition and adjustment of the instruments, at their stations.

Gun and pit commanders are, under the emplacement officer, responsible for the efficiency of the personnel and the condition of the matériel pertaining to their emplacements.

Gun pointers are responsible for the condition and adjustment of the sights.

A **mechanic** is assigned to a pit, or emplacement of 8-inch caliber or above, or to each battery of lesser caliber. He is in charge of all small stores and supplies pertaining to the battery.

6. Manning tables will be kept in each barrack, showing the positions of all men assigned for drill.

Manning tables are also posted:

In coast defense headquarters, showing personnel for headquarters, signal stations, boats assigned to headquarters.

In each fort commander's station, showing personnel of station, searchlights, power plant, signal station, switchboard, boats assigned to fort command, meteorological station, tide station.

In each support commander's headquarters, showing personnel for each element of landward defense.

In each fire commander's station, showing personnel of station, power station, searchlights.

In each battery commander's station, showing personnel of range, and gun or pit sections.

Manning tables are made out by the senior officer of the unit from the personnel of the organizations composing that unit.

MANNING PARTY FOR FORT COMMANDER'S STATION.

7. Fort commander, personnel officer, matériel officer, master electrician or electrician sergeant, observer, reader, recorder, operator for each telephone and for each searchlight controller, and orderlies.

MANNING PARTY FOR FIRE COMMANDER'S STATION.

PRIMARY (F'): Fire commander, communication officer, electrician sergeant, observer, reader, recorder, operator for each telephone and searchlight controller; plotter, assistant plotter, and two arm setters, when the plotting board is used; orderlies.

SECONDARY (F″): Observer, reader.

MANNING TABLE FOR RANGE SECTION (GUNS).

BATTERY COMMANDER'S STATION:

Battery commander. (Not member of section.)
Battery commander's observer.
Operator for each telephone (F. C. and observing stations).
Buglers.

PLOTTING ROOM:

Range officer.
Plotter.
No. 1, assistant plotter.
No. 2, primary arm setter.
No. 3, secondary arm setter.
No. 4, range board operator.
No. 5, deflection board operator.
No. 6, range transmitter.
Necessary telephone operators on lines to observing and B. C. stations.

OBSERVING STATION (FOR EACH):

Observer.
Reader.

EMERGENCY (OBSERVING) STATION:

Observer.
Reader (when type of instrument used requires it).
Necessary telephone operators on lines to B. C. station and plotting room (or megaphone operator).

MANNING TABLE FOR RANGE SECTION (MORTARS).

BATTERY COMMANDER'S STATION:

Battery commander. (Not member of section.)
Assistant battery commander.
Battery commander's observer.
Azimuth keeper.
Operator for each telephone (F. C., observing stations, plotting room, and pit when distant).
Buglers.

PLOTTING ROOM:

Range officer.
Plotter.
No. 1, assistant plotter.
No. 2, primary arm setter.
No. 3, secondary arm setter.
No. 4, azimuth computer.

No. 5, operator of device for sending data to pits.
Necessary telephone operators on lines to observing and B. C. stations, and to pits when distant.

OBSERVING STATION (FOR EACH):
Observer.
Reader.

EMERGENCY (OBSERVING) STATION:
Observer.
Reader (when type of instrument used requires it).
Necessary telephone operators on lines to B. C. station and plotting room (or megaphone operator).

CHAPTER II.

GUNNERY AND BALLISTICS.

POINTING DEVICES.

8. Pieces are pointed with the aid of the following devices: telescopic sight, quadrant, range drum, and azimuth circle.

The advantages gained in using telescopic sights are increased power of vision and consequent decrease of personal error, as well as to enable the gun to be aimed more rapidly.

The telescopic sights in use are the old trunnion sights, and the 2-inch and 3-inch sights. The former have two levels, one for cross-leveling and the other, together with the elevation arc, for use in giving quadrant elevation.

The 2-inch and 3-inch sights are mounted in sight brackets, which can be given a vertical motion to bring the target in the field of view, and a lateral motion for deflection. The sight bracket deflection scale is graduated from left to right, whereas in the old sights it is from right to left; this difference arises from the fact that in the old model sight the front sight (movable wire) moves, while in the 2-inch and 3-inch the rear sight (peep) moves. In either case, increasing the deflection acts to throw the next splash farther to the right, and *vice versa*. (See pars. 112 and 121.)

The arrangement of parts in all telescopic sights is, in general, similar. The objective forms an image (when focused) on the cross wires, this image being erected by the erecting prisms. The eyepiece magnifies this image. Good definition (*i. e.*, vision) without parallax is obtained by focusing so as to bring both image and cross wires in the focal plane of the eyepiece to suit the particular observer. For focusing, see "Position Finders," Chapter V.

Quadrants attached to mortars are used to give quadrant elevation (*i. e.*, elevation above the horizontal plane) by setting the angle on the quadrant and elevating the mortar until the bubble is in the middle of the level. The detachable quadrant can be similarly used. For mortars, the field of fire is divided into zones, nine for service and three for subcaliber. To accommodate abnormal velocities and inaccuracies in plotting, adjacent zones overlap by about 500 yards. Each zone has a different powder charge, and lighter projectiles are used in the outer zones. Quadrant elevations, 45° to 65°, are employed to cover each zone; 45° giving the maximum range attainable.

Elevation disks on gun carriages connected to move past a pointer as the gun changes in elevation are so graduated in service and subcaliber ranges (also 0, 5, and 10 degrees) that the gun will have the correct quadrant elevation for the range indicated by the pointer. (See par. 13.)

The azimuth circle is graduated in degrees and numbered, and the subscale (reading hundredths) attached so as to read zero when the piece points south.

POINTING METHODS.

9. CASE I. Direction and elevation are both given by sight—no longer used in our cannon, but may be used in rapid-fire guns, or in major caliber guns which have sight brackets on their trunnions, in which case the sight is set for an elevation (sight) corresponding to the range of the target and the gun elevated until the horizontal wire of the sight is on the water line of the target.

CASE II. Direction is given by the sight and elevation by the range scale, used on all of our guns. The gun may also be laid for range, without using the range scale, by elevation (called quadrant elevation); this elevation, corresponding to the corrected range, is taken from range table corrected for height of site and curvature, and may be set off on clinometer, quadrant, or telescopic sight when there is a sight bracket on the gun trunnions, and the gun then elevated until the bubble is in the middle of the level.

CASE III. Direction is given by the azimuth circle and elevation by the range scale or quadrant. Used by all mortars. May be used on guns, the range being set off on the range scale or quadrant elevation used instead, as in Case II.

In Cases I and II the gun is fired immediately after it is pointed. In Case III the gun or mortar is fired at a signal from the battery commander, given when the target crosses the vertical wire of his instrument (set in azimuth for predicted point), which should be at the expiration of the prediction interval.

The normal pointing method for gun batteries is Case II. If the sight standard becomes injured, or if fog interferes, Case III or else salvo points can be used.

POINTING AND PREDICTION TESTS.

10. Required weekly during outdoor period on Form 817, to be approved by the fire commander and posted on the company bulletin-board.

GUNS. The battery commander (unknown to the gun pointer) sends to plotting room an assumed deflection for wind and drift. The platen is set at this assumed deflection, and, using a moving target, the deflection is computed and sent to the guns. A noncommissioned officer, using a stop watch, determines, from a range table, the time of flight corresponding to the corrected range received. The gun-pointer sets his sight at the deflection received and commands **FIRE** when the piece is pointed; traversing is stopped, and the gun-pointer follows the target with the movable wire or sight bracket and reads the deflection when the signal **HALT** is given at the expiration of the time of flight. The difference between the deflection read and that assumed by the battery commander is the error. A more satisfactory method is when the normal system of fire-control is employed, using the actual wind reference numbers and drift corrections on the deflection board, and keeping a record of all data, and readings determined by the gun pointer, determining the errors afterward.

PROBLEM: Assumed deflection, 3.65; deflection sent to gun pointer, 3.20; reading of deflection scale at expiration of time of flight, 3.60; the error, then, is 3.65 − 3.60 = .05.

The excellence of the gun pointer's work is determined by the accuracy of his pointing and by the promptness with which he gives the command **FIRE** after the piece has been laid and the command **READY** given. A record showing the range, error, time from **LOAD** to **READY,** and the time from **READY** to **FIRE,** is kept for each trial.

MORTARS AND GUNS, CASE III. The azimuth of the predicted point from B. C. station and time of flight is sent to the B. C. station and the former set off on the B. C. instrument; at the command **FIRE,** given when the target crosses the vertical wire, the target is followed by turning the azimuth crank, and at the signal **HALT**, given at the expiration of the time of flight by an assistant equipped with a stop watch, the azimuth of the target is read; the difference between this reading and that of the set-forward point from the B. C. station, determined from the plotting board, is the error in prediction.

11. A **line of direction** is the line drawn from the muzzle (with plotting board gun arm) to the target at instant of splash.

Deviations are either: (1) the actual distances of the splashes from the target, in which case they are called **absolute deviations;** or (2) the rectangular coördinates of these distances, and are either **longitudinal** or **lateral.**

The line of direction, together with the line drawn through the target at right angles to the line of direction, form the axes to which these coördinates are referred.

The **lateral deviation** is the perpendicular distance (measured right or left) between the splash and the line of direction.

The **longitudinal deviation** is the perpendicular distance (measured over or short) between the splash and the line drawn through target at right angles to the line of direction.

The **mean lateral deviation** is the mean of the algebraic sum of the lateral deviations; *i. e.,* it is the difference between the sum of the plus and minus values divided by the number of shots, the sign of the greater being given the result.

The **mean longitudinal deviation** is the mean of the algebraic sum of the longitudinal deviations.

The **mean absolute deviation** is the mean of the algebraic sum of the absolute deviations; it is also equal to the square root of the sum of the squares of the mean longitudinal and mean lateral deviations, The **range deviation** is the difference between the range to splash and range to target at instant of splash. This is equal to the longitudinal deviation if the shot is a line shot (*i. e.*, when the lateral deviation is zero), and it closely approximates its value at other times.

Lateral deviations are determined from the shore, first in angle (or mils) and then converted into yards; longitudinal deviations are measured from the plot made from measurements taken from shore and tug. (See pars. 117 and 123 and cut opposite par. 117.)

The **center of impact** of a group of shots is the mean position of the points of splash. Its distance from the target along the mean line of direction is equal to the mean longitudinal deviation of the splashes; its distance right or left of the mean line of direction is equal to the mean lateral deviation of the splashes.

The center of impact of a series of shots fired from a piece laid at the same elevation may be determined in two ways: (1) when referred to the battery, it is equal to the mean of the sum of the ranges (also mean azimuth) to the several splashes; (2) when referred to the target, it is equal to the mean longitudinal and mean lateral deviations.

In a series of shots fired at the same elevation, the difference between the longest range attained and the shortest range is referred to as the "*maximum dispersion.*" Fired at a moving target, the "maximum dispersion" is the arithmetical sum of the greatest *plus* and the greatest *minus* range deviations; except that if all shots fall on the same side of the target, it is the diffierence between the greatest and least range deviations.

(See next paragraph for shots fired at different elevations, and examples.)

12. An **error** is either: (1) the actual distance of a splash from the center of impact, in which case it is called an **absolute error**; or (2) the rectangular coördinates of this distance, and is either **longitudinal** or **lateral.**

(Note that deviations are measured from the target, while errors are measured from the center of impact.)

Lines drawn through the center of impact parallel and perpendicular to the line of direction form the axes from which lateral and longitudinal errors, respectively, are measured in a manner similar to that for corresponding deviations.

Errors are calculated by subtracting algebraically the mean longitudinal (lateral or absolute) deviation from the longitudinal (lateral or absolute) deviation of each splash.

The mean of the arithmetical sum of the longitudinal (lateral or absolute) errors, without regard to algebraic sign, is called the **mean longitudinal** (lateral or absolute) **error.**

For example:

Actual range to target at instant of splash.	Range to splash.	Longitudinal deviations.	Center of impact.	Longitudinal errors.
5,000	5,110	+110	4,963.333	+146.667
5,000	4,780	−220		−183.333
5,000	5,000	0	(−36.667)	+ 36.667
	3)14,890	3) −110		3)366.667
	4,963.333	− 36.667 (mean).		122.222 = mean.

The errors determined from this example are armament errors.

Errors are of two kinds—**personnel** and **armament** (matériel). Personnel errors are those chargeable to the personnel of range section in computing, applying, or transmitting data, or to gun pointer or range setter not properly pointing or using data sent from plotting room; such errors are determined by analysis, a complete record of all data being kept for the purpose. Armament errors are those chargeable to matériel, such as gun, carriage, ammunition, and other undetermined causes. (The muzzle velocity is also affected by the seating of the projectile, this being really chargeable to the personnel.)

When the shots are fired with different elevations, as in service practice, the deviations are measured from the towed target in its different positions at the instant of splash, and the errors are determined mathematically from these deviations, as follows:

Range to target at instant of splash.	Longitudinal deviations.	Mean longitudinal deviation (center of impact).	Longitudinal errors.
5,000	+ 50		+ 70
5,400	0	−20	+ 20
5,800	−110		− 90
	3) − 60		3)180
	− 20		60 = mean.

These are the errors entering the figure of merit. If no errors were made by personnel, they become "armament" errors; but if mistakes were made, they are chargeable both to personnel and matériel.

When personnel errors are made, the armament errors can be calculated mathematically from deviations which are measured from expected splashes, instead of from the towed target; the expected splashes are obtained by subtracting the range board correction from the range drum setting, and then applying the gun and level difference in the opposite direction to which it was applied when taken from the time-range board.

If a series of shots are fired from the same piece under the same conditions of pointing and atmosphere, the projectiles would not all strike the same point, but would be more or less symmetrically disposed about the center of impact. Near the center of impact the grouping would be denser, but would decrease as the distance from the center of impact increased.

After having computed the mean longitudinal (lateral or absolute) error as explained, the probability of a future shot not exceeding any particular error can be calculated by probabilities. That error in which it is an even chance it will not be exceeded by any shot in that direction, is called the "probable error."

The "probable error" in any direction is equal to the mean error multiplied by .845; this does not mean the probability of hitting the target, but indicates the probable (*i. e.*, even chance) divergence of a shot from the center of impact fired under the same conditions. If the battery commander is to intelligently make corrections from the observation of fire of either trial or record shots, he must know what to expect of the gun (*i. e.*, its probable error).

To illustrate: If the mean longitudinal error of a gun, determined from a series of shots, were ± 40 yards, the probable error would be .845 × 40 = 33.8 yards (this value, .845, is determined from mathematics of probabilities).

If parallel lines are drawn perpendicular to the line of direction on either side of the center of impact, plus and minus the probable error, they will form the probable longitudinal (50%) zone, which should contain 50% of all shots fired under the same conditions. The 50% lateral zone can be determined similarly.

If two other pairs of parallel lines are drawn parallel and perpendicular to the line of direction and distant from the center of impact ± 4 times the probable error, they will form the 100% lateral and longitudinal zones respectively.

The intersection of the 50% zones form the 25% rectangle, and the intersection of the 100% zones form the 100% or total rectangle; any shot falling without the total or enveloping rectangle is regarded as abnormal.

In determining the muzzle velocity developed in a series of shots, the probable longitudinal error should be determined from all the shots of that series, unless one or more shots are abnormal in which case they should be rejected. Mathematics shows that in a series of a few shots there may be abnormal ones which fall within the total rectangle. To determine an abnormal shot, multiply the mean longitudinal error of that series by the following number, viz.: 1.72 when *n* (the number of shots in the series) = 3; 1.92 when *n* = 4; 2.06 when *n* = 5; 2.17 when *n* = 6; 2.26 when *n* = 7. If the longitudinal error of any shot is greater than this product, it should be rejected; the new center of impact should then be computed from the longitudinal deviations of the remaining shots and the test applied for any other shot which may appear abnormal.

This serves to show that range corrections based on observation of fire which is allowed in target practice should not be made except as the result of several shots.

By "accuracy of fire" is meant the satisfactory grouping of shots about the center of impact; while "accuracy of practice" is having the center of impact at the target.

RANGE BOARD CORRECTIONS.

13. The range scale of a gun carriage is, with the aid of a clinometer, graduated from a range table which has been corrected for height of site (*i. e.*, height above low water) and curvature of earth, there being for each battery such a range table which is constructed for normal muzzle velocity, zero tide, zero wind along range, and normal atmosphere. When a normal projectile is fired from a gun with normal muzzle velocity into normal atmosphere, and the wind and tide are zero, it will strike at a range equal to the setting of the range disc if the latter be in adjustment; the projectile in describing a trajectory is drawn vertically downward from the line of departure by gravity, while its velocity along the trajectory is diminished each succeeding instant by the resistance of the air. If the velocity is less, due either to powder or the increased resistance of dense atmosphere, or wind blowing against the range, the distance passed over each second will be less and, the action of gravity remaining the same, the trajectory will be lower than the normal trajectory and the projectile will fall short. Opposite conditions produce a higher trajectory and an increase of range.

If the muzzle velocity, atmosphere, wind, or tide is other than normal, corrections therefor are made on the range board and a further "corrected range" obtained. The setting of the range drum when corrected for gun difference and difference in level of base ring is the "corrected range" for that particular shot.

If, in the firings, the splashes fall short, the muzzle velocity used on the range board is too high, and *vice versa*.

Normal atmosphere is when the barometer is 29.53 inches and thermometer 59° F. An increase in the barometer indicates heavier, and therefore denser, air, which offers more resistance to the projectile, causing it to fall short; a fall in the thermometer, indicating contraction of the air, making it denser, has the same effect. It thus appears that we can have any number of atmospheres of normal density (16) and resistance, depending entirely on the relative readings of the thermometer and barometer.

A trajectory is based on the range. A rising tide causes the trajectory to be intersected by the water short of the target by an amount equal to the height of tide multiplied by the cotangent of the angle of fall.

The reference numbers on the range board increase from left to right—zero wind being 50, and normal atmosphere 16. A reference number lower than normal indicates conditions which offer increased resistance, causing the projectile to fall short, and therefore requires a corrected range greater than the actual, and *vice versa*.

14. PROBLEM 1: Trial shots being fired at a fixed point as prescribed in C. A. I. O., 1916.

No.	Point Fired at.		Splash.	
	Range.	Azimuth.	Range.	Azimuth.
1	6,000	141.00	6,040	141.10
2	6,000	141.00	6,000	141.00
3	6,000	141.00	5,900	141.05
Solution:			3)17,940	3)423.15

Center of impact = 5,980 yards, 141.05 degrees.

Correction for deflection would be made on deflection board by setting pointer for mortars (auxiliary or sliding scale for guns) to 2.95 (*i. e.*, 3.00° − .05°). The deflection correction determined for mortars at a particular elevation may not be correct at another elevation until a percentage factor has been applied thereto.

Correction for range for guns would be made by determining a new M. V. as explained under "Muzzle Velocity Chart," Chapter V.; and for mortars by sliding in the zone slide 20 yards (*i. e.*, 6,000 — 5,980 = 20), or determining a new M. V. from chart when used. The correction, whether for range or muzzle velocity, determined for one zone, may not be correct for another zone unless a percentage factor is applied thereto. Such a correction for the several zones is called a "zone-to-zone" correction.

Problem 2: Trial shots might be fired at a material target anchored at the desired point. In this case the ranges for the different shots might vary slightly.

No.	Range to Target.	Splash.			
		Over.	Short.	Right.	Left.
1	5,000	+90		+ .05	
2	5,010		−30	0	0
3	5,020	0	0		− .15
	3)15,030	+90	−30	+ .05	− .15
		−30			+ .05
Mean range =	5,010				
		3)+60			3)− .10
		+20			− .03°

The center of impact is 5,010 + 20 = 5,030 yards, and .03° left.

Correction for deflection would be made on deflection board by setting pointer for mortars (auxiliary or sliding scale for guns) to 3.03° (*i. e.*, 3.00° + .03°).

Correction for range for guns would be made by determining a new M. V.; and for mortars by moving out the zone slide 20 yards, or determining a new M. V. from chart when used. (See paragraphs 45, 46, 49, 50, 52.)

FORMULA FOR DANGER SPACE.

15. The danger space of any target is calculated from the formula,

$$\text{Danger space} = h \cot(\omega + \varepsilon),$$

in which h is the height or free board of assumed target, ω (omega) is the angle of fall for the corrected range (range drum) used, and ε (epsilon) is the angle of depression of the target below the gun trunnions. ε is the angle whose tangent is the height of gun (including curvature of earth) above the water, divided by the actual range to target. The earth's curvature may be calculated from the formula,

$$\text{Curvature in feet} = .2154 \left(\frac{\text{Range (yds.)}}{1{,}000}\right)^2$$

ADJUSTMENT OF CENTER OF IMPACT TO CENTER OF RECORD TARGET.

16. If muzzle velocity obtained from trial shots is used and no correction for danger space is made, the center of impact should fall at the water line of the target, instead of in the center of the record target, and the probability of hitting would consequently be less. The adjustment of the center of impact to the center of the record target is called the "danger space correction," and is accomplished in practice by adding to the tide an amount calculated from the following formula, and using the resultant curve on the range board, instead of the curve representing the actual state of tide:

$$\text{For major caliber guns, correction (in feet)} = \frac{39 \text{ feet} - 30 \text{ feet} \tan \omega}{2}$$

$$\text{For 5'' and 6'' guns, first practice, correction} = \frac{21 - 30 \text{ feet} \tan \omega}{2}$$

These formulæ neglect the small central section of the target on account of possible deflection errors, and consider only the intermediate section. ω (angle of fall) is taken from the range table for the approximate corrected range of the practice. For rapid-fire guns, and 5-inch and 6-inch except for first practice, the danger space correction would be 5 feet.

CHAPTER III.

AMMUNITION.

FUSES.

17. A fuse is a device for igniting the bursting charge in a projectile.

Fuses are classified, according to construction, into (1) ring resistance, (2) centrifugal, (3) combination time and percussion, and (4) detonating; they are further classified, according to location in the projectile, into (1) point and (2) base.

All four classes are used in field and siege matériel, while the detonating only is used in armor-piercing and deck-piercing projectiles and mortar torpedo shell. All of the fuses named are percussion fuses (*i. e.*, burst on impact); the combination fuse has in addition a time element, the shock of discharge causing a separate plunger to strike a cap and ignite a train of powder, which, if set short enough, will burst in air—otherwise on impact. Under each of the four classes are several kinds of fuses designed to accommodate the muzzle and rotating velocities of various calibers.

Detonating fuses, so called on account of the special detonator necessary to explode the bursting charge, are used in all projectiles containing high explosive.

The detonating fuse used in coast artillery is the "major caliber base detonating fuse" for mortars and guns 8-inch and above ("medium caliber" for 5-inch and 6-inch guns, and "minor caliber" for 3-inch and under); fuses for shot are delay action, so as to allow perforation of armor before bursting; those for shell are non-delay, except that fuses for D. P. shell (when used against ships only) are delay action.

The action of a percussion fuse is as follows: In those having ring-resistance plungers the shock of discharge throws the plunger sleeve to the rear, uncovering and gripping the firing pin; when the projectile strikes, the plunger and firing pin move forward, striking the percussion composition and igniting the bursting charge; in centrifugal plungers the rotation of the projectile opens the plunger's halves and adjusts the firing pin in position ready to strike on impact. A fuse is "armed" when the firing pin is in position, uncovered and ready to strike on impact; this is accomplished by the shock of discharge in ring resistance plungers and by rotation in centrifugal plungers.

PRIMERS.

18. A primer is a device for igniting the powder charge in the gun.

Primers are classified into (1) friction, (2) electric, (3) combination electric-friction, (4) percussion, and (5) igniting.

The combination and electric primers are used in firings with service charges; the drill primer (friction), on account of its lesser cost and adaptability for reloading at posts, for drill and subcaliber practice; the percussion primer in fixed ammunition for the 3-inch gun and .30 caliber rifle; and the igniting primer in the cartridge case of subcaliber ammunition—20 grain for guns and 110 grain for mortars.

The action of a primer is as follows: In friction primers a roughened wire is pulled through the friction composition, causing fire; in electric primers the electric current passing through a fine wire heats it to a red heat; in percussion primers a firing pin strikes the friction composition, causing a spark; in igniting primers the flame from the friction or electric primer ignites the igniting primer and is further transmitted to the powder charge. All primers used in modern cannon are "obturating"; *i. e.*, they prevent the escape of gas to the rear by the thin walls of the primer body being forced against the vent, and the conical surface of the wire being forced into its seat by the action of the powder pressure. Combination primers failing to fire by electricity may be fired by lanyard, but the converse is not true, on account of the parts being disarranged.

The friction and percussion composition used in fuses and primers is a mixture of chlorate of potash, antimony sulphide, sulphur, and ground glass, in varying proportions.

Used drill primers are cleaned in lye or sal-soda water, dried, and turned in to the ordnance storehouse, where the bodies are shaped in the resizing press and reloaded as follows: With the aid of the assembling tool a serrated wire is placed in the primer body, a button wire screwed to its end, a charge of black powder is poured in, and the end sealed with a moistened closing cup pressed down. Butt on wires are also turned in.

Primers that misfire are turned in to ordnance storehouse.

POWDERS.

19. There are two kinds of gun powder used in our service, viz.: black and smokeless.

Black gun powder (also called "rifle powder") is a mechanical mixture of nitre, charcoal, and sulphur, in the approximate proportion of 75, 15, and 10, respectively. It is used in the coast artillery service for blank charges, in primers, and as an igniter at the ends of the charges of smokeless powder.

Smokeless powder in our service is cellulose (*i. e.*, cotton) dipped in nitric and sulphuric acid (hence the name "nitro-cellulose"), reduced to a pulp, and then colloided (*i. e.*, dissolved in an ether-alcohol mixture); the solvent is then removed, and the doughy mass forced through dies, cut into grains, and then dried—the drying process occupying several months. The grain used is single-perforated for .30 caliber rifle and subcaliber ammunition, and multi-perforated for larger calibers. The very important "critical" dimension of a powder grain is the thickness between two adjacent surfaces (called "web thickness"), there being different size grains with different web thicknesses for each caliber.

The powder charge of a gun (also called "propelling charge") is made into one or more sections, the bags being of raw silk, with the igniter of black powder quilted at each end. Each section is shipped from the arsenal to the forts in metallic storage-cases (zinc or corrugated iron). The cases are hermetically sealed (air-tight) with a soldered strip, and are opened by tearing off this strip with pliers. Empty cases and protection caps are turned in to the ordnance storehouse for return shipment to arsenals.

The later issues of 5-inch and 6-inch charges have also a core igniter extending through the axis of the charge; this gives extra rigidity and assists in the ignition and inflammation, thus giving more uniform velocities. Later issues for major caliber guns also have core and end igniters and are made up in a single section; this facilitates ignition, thereby giving more uniform velocities. Bags for converting multiple sections into single sections are also issued.

Mortar charges are issued either (1) in complete charges for each zone, or (2) in base charges and increments, the increments being added to the base charges for the different zones. The base charges only have igniters (core or base), and, to insure their being inserted next to the breechblock, are covered with red cloth or painted red.

POWDER BLENDING.

20. Powder blending is for the purpose of obtaining charges which give uniform muzzle velocities; this is accomplished by distributing, among all the sections to be formed, an equal amount from each original section used. The blending of two or more lots is called "compound blending"; each lot is first blended separately, then together—a tabulated record being kept to insure proper distribution.

Powder is blended in the shade, so that its temperature will not be unevenly affected by the sun's rays; also in dry weather. as the presence of moisture on powder lowers the muzzle velocity. The gross weight of each section should be compared with the tag and a report made if a marked discrepancy exists.

Powder of a single lot may be blended in two ways: (1) By the shovel or cycle method, in which a single pile, containing all of the powder, is shoveled from the bottom into five or more circular piles, and then back; this operation, called a "cycle," is performed five times, and an equal amount of powder, by weight, placed in each section—the mixing to be done on paulins. (2) By counting grains, in which an equal number of grains, determined by calculation, are taken from each section to make up a new section; the **net weight** of all sections being then made equal. This is accomplished by placing the opened sections in a row, and having each man with a case pass along and take, by count, the determined number of grains from each section. A net weight that insures enough powder for the last section should be decided upon, the remainder being equally distributed among the various sections.

The scales should be approximately level, and tested with test weights. The slide should be clamped, to prevent "creeping." Each time, in weighing, place the box or can carefully and accurately in the same position; observe that the beam balances in the middle position when released from the "down" and then "up" position.

A section is opened by ripping the seams at one end and also the lacings. In remaking, they should be rolled and laced tightly, so as to insure all rigidity possible. They are then placed in the cases, and the latter sealed with paraffine applied (melted) with a brush, and locked in the magazine. These cases should be examined after each firing, and resealed if jarred open.

All men should be directed to dispose of all matches and lighters before working with powder.

CARE AND STORAGE OF EXPLOSIVES.

21. Magazines must be kept scrupulously clean, free from all foreign materials; the ground around the storage place free from grass or other things that may increase fire risks, and keys only in the possession of thoroughly responsible men. A standard thermometer should be hung therein.

Magazines are ventilated to allow to pass out (1) gases which come from explosives, and (2) moisture which collects through seepage or condensation. They are opened for ventilation only when the outside air is dry. Generally speaking, the conditions are favorable for ventilation when the temperature inside is higher than that outside, as the incoming air, being raised in temperature, can not deposit any of the moisture it may contain; but when the latter is very dry, as may be the case during the summer, the magazine may be ventilated with advantage when its temperature is below that of the outside air.

Accurate information showing when to ventilate is determined from the wet and dry bulb thermometers. These are ordinary thermometers, the wet bulb being covered with a wick leading to a cup filled with water of the temperature of the air. The water, through capillary action, forms around the bulb, where it is evaporated—the amount of evaporation being dependent on the dryness of the air, thereby causing a lower reading than the dry bulb. The method is as follows: Enter Table V. with the reading of dry bulb and difference between the two bulbs as arguments, find the weight of water vapor in one cubic foot of air; then, with this weight, enter Table VI. and find the temperature for the magazine thermometer for proper ventilation. This method insures that the incoming air, even if lowered in temperature, will not cause any moisture to be deposited. These tables are in the forts.

A rough determination can be made, however, from the barometer; a low reading, particularly on warm days, indicating moist air—dry air being heavier than moist air; this indication, so far as ventilation is concerned, is undependable, for the reason that moisture may actually be a considerable distance above the earth.

When the temperature of magazines exceeds 100° F., steps should be taken to cool the magazine or else remove the explosive.

Once each month the responsible officer will inspect each storage place and see that the instructions are carefully observed.

Cases containing powder or explosives will be handled gently—rolling, sliding, or dropping avoided; and must not be exposed to the sun's rays. Whenever there is more than one kind of explosive in a magazine, the different kinds will be placed in separate piles; powder of different lots will also be kept separated.

Smokeless powder is stored alone in the driest available magazine, the cases standing on end, with skids between tiers and on the floor. A fresh sample of powder is taken twice annually from each lot (except fixed ammunition) and placed in an air-tight bottle, which is kept in the magazine. A fresh strip of test paper is placed in the bottle every thirty days and inspected, without opening the bottle, every week; the bleaching of the paper within thirty days indicates deterioration and is reported to the Ordnance Officer for further report to the War Department.

Dynamite, explosive "D," wet guncotton, and trotol may be stored in the same magazine, but in separate piles.

Black powder is stored alone.

Fuses, primers, and commercial detonators may be stored together in any available dry place, but never with powders or explosives.

Guncotton and trotol are used in submarine mines. Dry guncotton, except the few primers assembled in a fuse can, should be wetted before being stored.

PROJECTILES.

22. Armor-piercing shot and shell for guns, and deck-piercing shell and torpedo shell for mortars, all made of steel, are used in actual service. For target practice, cast iron projectiles of approximately equal dimensions are used. Shell, having the cavity extending beyond the bourrelet, have not the penetrative power of shot, but carry more explosive and are used at longer ranges. The armor-piercing cap increases the penetrative power; the ballistic cap, changing the shape of the projectile, decreases the air resistance, thereby increasing the range. Broad rotating bands more effectually prevent the escape of gas and give more uniform velocities.

One-pound projectiles are used in subcaliber guns, for guns (except 3-inch, which use .30 caliber), and eighteen-pound projectiles for mortars; a heavier projectile being necessary for mortars to make a splash which can be seen. The caliber of the one-pounder projectile is 1.46 inch; that of the eighteen-pounder is 2.95 inch.

Projectiles are piled with points toward the wall, on skids, so that no weight rests on rotating bands. Care should be taken not to injure rotating bands in handling. Projectiles of different kinds are piled separately. When magazines are wet, projectiles, after having been painted, will be slushed.

Lot numbers are stamped on rotating bands and stenciled on base cover; they serve to identify the projectile and the fuse to be used.

Colors to indicate the material of projectiles and the contents are as follows: green for cast iron; warm gray for cast steel; blue gray for forged steel; red for black powder; and yellow for explosive "D."

Steel projectiles are painted as follows: Body black; a band around center of gravity, one-half caliber wide, and two-thirds of ogive, including cap for shell (entire ogive for shot), of the color indicating the material of which made; body in rear of rotating band and the base cover of the color indicating the bursting charge. A longitudinal black stripe about one inch wide on each quadrant, beginning at rotating band and extending to groove or across base, indicates a projectile filled, but not fused. Torpedo shells are painted black on body and ogive, and have a center of gravity band of color indicating material. Cast iron projectiles are painted black on body and have a green center of gravity band, and an additional green band of same width between rotating band and center of gravity band. The entire projectile of subcaliber ammunition in front of rotating band is black (sometimes with green center of gravity band for mortars).

LOADING (FILLING) PROJECTILES WITH EXPLOSIVE "D."

23. The base plug of the projectile is removed, and cavity cleaned and painted with rubberine or other special paint provided for this particular purpose. The projectile is placed in a vise, base up, under the pile-driver, and explosive "D" in small quantities poured in (about 10% of the charge) and rammed into a compact mass each time, until the charge is up to the bottom of the base plug. The loose explosive is then removed, the threads cleaned with alcohol, greased with vaseline, and a disk of paraffine paper put on the explosive, and the base plug screwed in tightly. Melted paraffine is then poured through the fuse hole so as to completely fill the space between the explosive and the base plug. With the drill and reamer the seat for the fuse is formed in the explosive, and the threads cleaned and greased. The plunger containing firing pin is now assembled in the fuse, the fuse stock painted with rubberine, and the threads greased with vaseline, after which the fuse is screwed into its seat. The depressions in the base of the projectile, such as wrench holes, etc., are filled with lead, and the base cover put in place and secured by hammering the caulking wire into the circular groove. The base cover protects the explosive from the powder gases.

PRESSURE GAUGES.

24. Used to determine the maximum powder pressure in cannon. There are three kinds: major, medium, and minor caliber. The major caliber is a "fixed" gauge (*i. e.*, screws into the obturator); the others are "loose" (*i. e.*, placed in the powder chamber). Copper cylinders, .5 inch long, are subjected to various initial pressures in a machine and the changes in length tabulated, thus forming a "tarage table." These cylinders are issued in packages, and marked with the initial pressure used. A new tarage table is computed for each new lot of copper cylinders, and care must be taken to see that the correct table is available for use.

A copper cylinder, placed under the piston of the pressure gauge, is compressed by the powder gases acting on the piston; the change in length (*i. e.*, "set") caused by the pressure of the gases is measured and the pressure computed by the use of a tarage table, the procedure being as follows: (1) Before using a copper verify its initial compression by subtracting its length from its mean length (shown in tarage table of same date of annealing the copper and approximately .5 inch) before it was initially compressed; then enter the second column "Mean Corrected Total Sets" with this diffierence, and the initial compression will then be found in the first column on the same line opposite; (2) Record the length before and after firing; (3) Subtract the length after firing from the length before firing, and with this difference enter the column "Mean Corrected Partial Sets," at the head of which is the range of pressures whose first figure is the initial pressure; the pressure corresponding to this "set" will then be found (by interpolation by proportion) in the first column on the same line opposite (when possible, solve by each method and check results). The expression "Partial Sets" means the change in length (*i. e.*, "set") caused by the powder pressure only; "Total Sets" means the total change (*i. e.*, "set") from the original length before it was initially compressed.

To prepare a pressure gauge, remove the closing cap and piston, clean and oil parts, select a copper cylinder which has been initially compressed from about 2,000 to 7,000 pounds less than the expected pressure of the round, and place it in the cylinder holder; insert piston and copper in gauge and screw in the closing cap, setting up tightly by means of wrenches. Force a gas check down on piston, apply a drop of heavy grease on gas check, place a copper washer around gauge, and screw into obturator spindle head, setting up tightly with a mallet and wrench. After firing, the gauge is removed, cooled in water, cleaned, and the copper measured; black residue in the gauge indicates leakage and possible malfunction.

In using the micrometer caliper, hold the copper firmly, but avoid squeezing. Read to third decimal place only; tenths (and thousandths in units of 25) on the hub, and thousandths on the spindle head; the latter are then added to the former. The general method of solution is the same whether the third or fourth decimal place is expressed in the problem.

Example: Expected pressure, 32,000 pounds; lengths of coppers before firing .4004, after firing .3752 and .3630; determine pressure indicated by each gauge.

Solution: In the second column find a number within .001 of .0996 (.5000 − .4004), in this case .0994, and in first column opposite will be found its initial (machine) pressure, viz., 28,000.

In column headed "28,000 to 35,000," the first number indicating the initial pressure, find the two numbers which bracket .0252 (.4004 − .3752)—*i. e.*, .0207 and .0258; the powder pressure will be found in the first column opposite through interpolation by proportion, as follows:

$$1{,}000 \times \frac{.0252 - .0207}{.0258 - .0207} + 32{,}000 = 32{,}882$$

If the tabulation of the initial compression is not available, or if the table does not extend sufficiently far to bracket the partial compression (*i. e.*, change in length), the solution by total compression, using the second column, is necessary. (On account of coppers not being exactly uniform when manufactured, a slight error enters in the method). For example, .5000 − .3630 = .1370, which is the total set. Now find, in second column, the bracketing numbers of .1370 and proceed as in the first solution. Thus:

$$1{,}000 \times \frac{.1370 - .1356}{.1403 - .1356} + 35{,}000 = 35{,}298$$

TARAGE TABLE.

(Mean length of cylinders before initial compression, 0.5 inch.)

Pressures per Square Inch, $^{1}/_{10}$ Square Inch Piston.	Mean Total Sets.	Partial Sets.	
		28,000 to 35,000.	32,000 to 40,000.
28,000	.0994	0	....
32,000	.1201	.0207	0
33,000	.1252	.0258	.0051
34,000	.1301	.0307	.0101
35,000	.1356	.0362	.0155
36,000	.1403	....	.0202

CHAPTER IV.

GUNS AND CARRIAGES.

CANNON.

25. Cannon are firearms not carried in the hands, and are classified as follows: (1) **Guns** are long compared to their caliber (30 to 50 calibers), have flat trajectories, and employ high muzzle velocities for direct fire at not exceeding 20° elevation; (2) **Mortars** are short for their caliber, employ low velocities for high-angle fire, and are used at angles above 45°; **Howitzers** are short guns with low velocities, and are used for curved fire at angles below 45°.

Caliber is the diameter of the bore, in inches, measured between lands. The length of a gun is expressed in terms of its caliber: as a 50-caliber 6-inch gun; this refers to a 6-inch gun, which has a bore and chamber 50 calibers (*i. e.*, 300 inches) long.

All cannon are rifled, and, excepting subcaliber guns, are either "built up" or "wire-wound"; in both types the shrinkage of hoops or the winding of wire on the tube increases the strength and permits the use of higher powder pressures. The inner surface of cannon is divided into the following parts, in order, beginning at the breech: breech recess, gas check seat, powder chamber, centering slope, forcing slope, bore. All of these surfaces, except the breech recess, are in the tube.

Guns on pedestal carriages, 6-inch or less, are termed "rapid-fire guns."

26. The **gas check pad,** in being compressed by the gases acting on the mushroom head, forces the exterior split rings out against the tube, thereby preventing the escape of gas. Upon the release of this pressure the elastic pad, with the aid of the split rings, assumes its normal shape. The interior split ring prevents the pad from being squeezed in between the filling-in disk and the spindle. The gas check pad is composed of asbestos and tallow, with a covering of canvas; to protect against injury and absorption of moisture, a mixture of equal parts of graphite and 4½ lubricant is thoroughly rubbed in before it is used, and renewed as required. (Some of the later gas check pads are made of asbestos and non-fluid oil, and are marked "N. F. O.")

To adjust pad: Close breech and rotate half way; tighten spindle nut as much as possible; if the breechblock can then be completely rotated, and when opened the pad can be turned by hand without longitudinal play, it is in adjustment, and the spindle nut should then be clamped.

27. To dismantle breechblock: Remove firing mechanism, open breech, and place a shot truck with tray under mushroom head, elevating it until against mushroom head; remove spindle nut and washers, and then move truck back, withdrawing spindle; in this operation the pad and rings should be held together and not allowed to fall apart. The filling-in disk, split rings, and pad can then be removed. In barbette and mortar carriages, the hoist or two men should be substituted for the truck. Assembling is in the reverse order, the pad fitting only when applied exactly as removed.

28. To dismount heavy breechblock (*i. e.*, remove it from the tray): With block on its tray, remove spindle and tray latch; pass a rope sling through the spindle cavity, and, with the aid of a gin or hoist, translate off tray and lower to platform.

29. Firing mechanisms are kept on guns only when in actual use. To attach: Clasp the hinged collar about the spindle; slip the safety bar into the notch of the housing; hold the housing over the hinged collar and screw the latter into the housing until the spring catch engages; while doing this, see that the guide bar enters the groove in the breechblock, and the pin of the safety bar slide enters the hole of the safety bar. Put the ejector in place, and, with the stop pulled out, lower the slide into position.

CARRIAGES.

30. Seacoast gun carriages are classified as follows:

(*a*) Barbette—where the gun is above the parapet at all times;

(*b*) Disappearing—where the gun is above the parapet for firing, but recoils below the parapet for loading;

(*c*) Masking parapet or balanced pillar mount—where the gun is above the parapet for loading and firing, but can be lowered below the parapet for concealment;

(*d*) Casemate or turret—where the gun fires through a port.

31. A gun carriage consists of the following: A base ring, which forms the lowest part of the carriage and provides the lower roller path and pintle surface, is bolted to the concrete platform. On this lower roller path run the conical traversing rollers, maintained in proper relative position by distance rings. On the traversing rollers rests the racer, which has a pintle surface enveloping the pintle surface of the base ring. The rollers and roller paths are protected by a dust guard, a section of which has to be removed when necessary to clean. On the upper side of the racer is bolted the chassis, fastened together by transoms, on which surface the top carriage recoils. On mortar carriages (Model 1896), fulcrum lugs, fastened to the racer, are substituted for the chassis, the top carriage rotating about these fulcrum lugs. Trains of gearing for elevating, traversing (and retracting, for gun carriages) are provided; also devices for pointing and firing the piece. The firing current is generated by a magneto or battery; the circuit is broken automatically by opening the breech, or by retracting the gun or depressing the mortar; the circuit can be completed by the safety firing switch by hand only when the disappearing gun is in battery, or the mortar elevated about 40°. For nomenclature and object of parts, refer to "Gunners' Instruction" and tables in the ordnance pamphlets.

ADJUSTMENT OF SIGHT STANDARD AND (ORIENTATION) OF AZIMUTH INDICES.

32. This is accomplished by "bore sighting." A bore sight (or the vent) is used in the breech, and a string along the vertical diameter of the muzzle. Sight through the bore and bring both sights (bore sight and string) on object at or beyond mean (5,000 yards) range; with the telescopic sight in adjustment on the sight bracket, parallax eliminated, cross-leveled, and vertical wire at normal (3.00°), the sight standard or bracket is then adjusted to bring the vertical wire on the object. A sight is numbered and is intended for a particular gun; only those used in bore sighting would be in correct adjustment.

The azimuth indices of the several guns of a battery are set to read the actual azimuth, from the directing point of the battery, of a point near the mid-channel at mid-range, when the guns are directed on said point. If there be more than one channel, the point selected should be midway between the several channels.

Mortars are bore sighted on a point (or in a transit set up on a point and oriented) near the battery; the azimuth indices are then set to the azimuth of this point, which was determined from a survey. If the transit is oriented so as to read true azimuths and then pointed into the muzzle, the azimuth indices would be set to read the "back azimuth"; the back azimuth is found by adding 180° to the true azimuth. The four mortars of a pit are oriented so as to be parallel when set at the same azimuth.

ADJUSTMENT OF RANGE OR ELEVATION SCALE, OR QUADRANT.

33. A clinometer, an instrument for measuring quadrant angles (*i. e.*, vertical angles from the horizontal), is used in artillery to adjust the range scales and quadrants, and to measure differences in level of the base ring.

Place the clinometer rest (bore plug) in muzzle; place clinometer, set at zero, on rest, level cross-level, and then elevate or depress gun until bubble is in center; reverse clinometer on rest, and if bubble does not remain in center, it is out of adjustment. (Adjustment of clinometer should never be attempted without express authority of the Ordnance Officer.) Direct the gun to middle of field of fire; set clinometer to angle corresponding to approximate range of practice, and elevate until bubble is in center;

then set range drum pointer to read the range corresponding to elevation used, taken from a range table corrected for height of site and curvature.* If no such range table is available, set clinometer at 5°, and adjust the pointer to read 5°. In using the clinometer, it should be protected from the wind, sun, and body. If the records of previous firings show that the several guns of a battery are not consistently shooting together, the pointers may be shifted an amount to correct for this difference; such adjustment is called "calibration." In adjusting the quadrant and auxiliary elevation scale on mortars, the clinometer of the later type only (the older type only reading to 15°) and rest are similarly used, 55° being the angle, and the quadrant adjusted so that when set at 55° the bubble remains in the center, and auxiliary scale reads 55°. A detachable quadrant which has been tested by a clinometer may also be used when the new clinometer is not available.

The differences in range to the target from the gun and from the directing point or directing gun are called gun differences.

Differences in level are determined by first directing the gun, set at any elevation, to the middle of the field of fire, the bubble of the clinometer, quadrant or sight (old model), in the center of the level, and at every 10° of the field of fire, right and left, measuring the angle of elevation; the difference in elevation from that of the initial position is the difference in level; the ranges (for guns) corresponding to these angle differences taken from the range table at the range of the practice, are combined algebraically with the gun differences, and the results, in multiples of five, with proper sign, chalked on the base ring or concrete, to be applied to the ranges sent from the plotting room. Note that the level correction is plus when the angle at the tested position is less than that at the original position, and *vice versa.* No correction for level is necessary at mortar batteries.

ELEVATING FRICTION MECHANISM.

34. The object of this device, a part of the elevating system, is to prevent injury to the teeth of the gears when the piece is fired. Such devices are on all disappearing and mortar carriages, except the 6-inch D. C., Model 1903, and 12-inch D. C., Models of 1897 and 1901; on these excepted carriages the shock is taken up by springs which connect the elevating arm to its slide.†

The device should be cleaned (disassembling to be done only by machinist when necessary), lubricated, and, with the gun depressed to the stop, adjusted so that slipping will just occur when there is further attempt at depression by applying the following forces: for 6-inch D. C., Model 1898, one man on one handwheel exerting 90 pounds; 10-inch D. C., Model 1894MI, one man on each handwheel exerting 100 pounds each; for all other disappearing and mortar carriages two men on each handwheel exerting 100 pounds each. The forces stated herein come within those prescribed in G. O. No. 63, W. D., 1914; will give good results and without damage to the parts.

---

*NOTE.—This table is an "elevation table," and later ones also contain a correction for jump.

†NOTE.—In the 8-inch D. C., Model 1894, and 10-inch D. C., Model 1894, the friction mechanism is not a link in the train of the elevating mechanism, but is merely a brake; these guns should be depressed to within 1° of the stop, so that slipping may occur when the prescribed force is applied.

DISMOUNTING MORTARS.

35. Mortars should be raised from their beds and the springs removed for cleaning every two years.

Take off guide caps and guides, and, using the spring compressors to prevent the springs forcing up the top carriage, unscrew piston rod nuts and rotate the recoil cylinders together to a vertical position. Place a block in muzzle and a 12-inch skid about 12 feet long under breech. Then, with the aid of cribbing and three 15-ton jacks (one under the block in the muzzle, and the other two at the ends of skid), raise the mortar, the top carriage rotating about the fulcrum, until the springs are fully extended, when they can be removed for cleaning and painting. The trunnion cap squares can then be removed and the top carriage, with the aid of a jack or gin, lowered sufficiently to enable one to clean the trunnion bearings, and the whole assembled in the reverse order.

CLEANING OF RECOIL CYLINDERS.

36. Recoil cylinders are cleaned twice each year. Hydroline oil is first drawn off into receptacles, using hose or buckets, and strained. Parts to be removed should be marked, to insure their being assembled correctly. The equalizing pipes may be cleaned, if necessary, by flushing or forcing through oil or kerosene with a force pump, but the pipes must not be removed for any purpose except by an ordnance machinist. When the oil, poured successively through the cylinders, drains through the pipes, it is evidence (except for carriages not in use for long periods) sufficient to indicate that the pipes are clear. Cylinders are kept filled to prevent rusting. To fill: Pour oil into one hole until it appears in the other.

Disappearing carriages (first method). Retract the gun and with the ropes slack away until the top carriage rests against two planks cut to hold the top carriage from the stop with the pistons in the middle of the cylinders. Remove piston rod brackets from the rear end, the two nuts from the front ends of the piston rods, loosen stuffing box follower, but do not remove packing, and remove rear cylinder heads, and slide all parts to the rear out of the cylinders. The cylinders and parts can then be cleaned with abrasives (not sandpaper), wiped clean, and the whole assembled in the reverse order. In case it is not desired to remove the piston rods, the cylinders can be cleaned with a force pump and kerosene, the latter being forced in all the crevices. After assembling, the cylinders are filled with hydroline, the filling plugs inserted, and the gun drawn from and let into battery slowly with the ropes, to insure there is no binding. It may be necessary to add more hydroline.

Disappearing carriages (second method). Put into cylinders ten gallons of kerosene and with the ropes draw the gun back and forward several times. Draw out kerosene and put in the same quantity of hydroline oil and repeat operation. This hydroline is then drawn off and used for cleaning purposes only, and the cylinders filled with clear hydroline. Do not trip unless cylinders are filled with hydroline.

Barbette carriages. Retract gun and set in two planks cut to hold top carriage from the stop with the pistons in the middle of the cylinders. Remove rear cylinder heads and piston rod nuts, and withdraw piston rods from the cylinders. The cylinders and sliding parts can then be cleaned with kerosene and abrasives (not sandpaper), wiped clean, and the whole assembled in the reverse order. In case it is not desired to remove piston rods, the cylinders can be cleaned with a force pump and kerosene, the latter being forced into all the crevices. After assembling, the cylinders are filled with hydroline and the gun retracted to the stop and let into battery with the ropes to insure that there is no binding.

Mortar carriages. Take off guide caps and guides, and, using the spring compressors to prevent the springs forcing up the top carriage, unscrew piston rod nuts, holding cylinders so that they will rotate together to a vertical position. Remove upper cylinder heads, loosen stuffing box followers, but do not remove packing, and with a gin withdraw piston from cylinder. The cylinders and sliding parts can then be cleaned with kerosene and abrasives (not sandpaper), wiped clean, and the whole assembled in the reverse order. In case it is not desired to remove the pistons, the cylinders can be cleaned with a force pump and kerosene, the latter being forced into all the crevices.

GREASE CUPS.

37. Grease cups, attached to gun and mortar trunnion bearings and to the front ends and middle of gun levers, are filled with No. 4½ lubricant (a thick grease), to protect against excessive friction. When filling, the cap is screwed down until the nut of the rod protrudes ¼ inch; when the rod does not protrude when the cap is fully down, the cup needs refilling, the cap being removed for this purpose.

RECOIL SYSTEM.

38. The front ends of recoil cylinders (bottom ends of mortars) are connected by an equalizing pipe, which equalizes the pressure in the two cylinders during recoil, thereby preventing jamming by one side recoiling faster than the other. In mortar carriages, if the pipe is injured, the holes entering the cylinder can be plugged and the firing continued; the same correction can be applied to gun carriages if the recoil is not too free. In disappearing carriages the equalizing pipe is connected through a connecting pipe and throttling valve to throttling pipes which enter the rear ends of the cylinders, thereby permitting a regulation of the flow of oil for the adjustment of recoil for proper loading position. In cylinders of gun carriages are throttling bars, which work in slots of the pistons; the bars vary in thickness, being thinner at the rear ends, so as to provide varying openings for the flow of oil, in order to accommodate the different velocities of recoil, thereby keeping the pressure constant. In mortar carriages, grooves cut in the walls of the cylinders are substituted for throttling bars—the grooves being deeper at the upper end. In some of the later models of gun carriages grooves have been substituted for throttling bars.

Recoil of gun carriages is taken up, (1) by the resistance the oil offers in being forced from one side of the piston to the other, (2) by the recoiling parts running up the inclined chassis rails, (3) by friction of the sliding parts; and also, in disappearing carriages, by raising the counter-weight. In mortar carriages recoil is taken up mostly by the oil, but a small amount is absorbed in the compression of the springs.

Recoil (recorded for each shot) is expressed in notches for disappearing carriages and in inches for other carriages. In mortar carriages a string is tied around the piston rod just above the follower, and after each shot its distance from the follower, added to any amount the carriage fails to go fully into battery (space between cross-head and balata buffer), is the recoil; in barbette carriages the string is tied around the elevating shaft instead. The string is readjusted after each shot.

The proper setting of the throttling valve is determined from the last firings, the record being in the emplacement book; opening the throttling valve one turn lengthens the recoil about three notches, and *vice versa;* an increase in temperature of 10° also lengthens the recoil one or two notches.

Counter-recoil is effected by the recoiling parts sliding down the inclined chassis rails and by the falling counter-weight; in mortar and pedestal carriages springs provide this motion. Counter-recoil buffers in each cylinder catch a portion of the oil at the end of counter-recoil, forming a cushion and preventing a jar; in some disappearing carriages buffer pipes open into these buffers, with a valve to regulate the oil and make this adjustment.

The buffer valve should be set at the setting employed at the last firing, and, with the cylinders filled, the carriage tripped several times to verify its correctness; if a rebound occurs, close valve or remove hand-weights; if it does not counter-recoil to stop, correct oppositely. A change in the throttling valve setting has no effect on the counter-recoil, but the buffer valve does affect the recoil; therefore the throttling valve must be closed the same amount the buffer valve is opened, and *vice versa*, to compensate for the change in the buffer valve.

Throttling valves are graduated in fractions of a square inch of opening, either in multiples of .04 or .05. In the first type a half turn corresponds to .013 square inch, in the second type to .025 square inch Buffer valves are denoted in notches; one notch equaling .006 square inch for 6-inch and 10-inch D. C., Model 1901, and 12-inch; and one notch equals .0015 square inch for 10-inch D. C., Models 1894 and 1896. In mortar carriages correct counter-recoil is obtained by adjusting the springs so they will return the cross-head to the balata buffers, with no rebound, when the mortar (elevated about 30°) is depressed rapidly against the stop; in making this adjustment the **lock must be held open,** otherwise it may be injured.

On those carriages which have a combination recoil and buffer valve the recoil, as well as the counter-recoil, is graduated in notches, 0 (closed) to 80 (½ square inch, open). Only on disappearing carriages which have the recoil cylinders vertical a change in the setting of the recoil valve does affect the counter-recoil, and allowance has to be made therefor; in this type of carriages the setting of the buffer valve is best determined by tripping, although the valve is marked for different temperatures of atmosphere to facilitate setting.

Carriages which can not be adjusted for recoil and counter-recoil as described require alteration either in the buffers, throttling bars, or grooves, by machinists.

STUFFING BOXES.

39. Stuffing boxes are intended to prevent leakage of oil, particularly during recoil and counter-recoil.

To unpack a stuffing box, draw off oil (except when packing upper box on mortars), remove follower and gland, and with a packing extractor or hook remove packing.

To pack a stuffing box, put in one ring at a time of Garlock's Waterproof Hydraulic Packing until six rings (five for mortars) have been inserted, being careful to break joints and to force each ring down with a wooden stick and mallet. Packing badly worn should be discarded; other packing that has been used should be put in after the new packing. The gland is then put in place, and the follower screwed in and adjusted with the force of two men working on the wrench (not using pipe or other extension).

CARE OF MATERIEL.

40. The oils furnished by the Ordnance Department are as follows:

Name.	*Use.*
Hydroline	For filling recoil cylinders.
Drawing compound	Sponging chamber and breech.
Kerosene	For cleaning purposes only.
Light slushing	For the bore and for the bright parts of guns and carriages when they are to remain unused for a considerable time.
Engine	For bright parts of guns and carriages when in daily use; and lubricating purposes where oil-holes or plugs are provided.
No. 4½ lubricant	For filling grease cups of heavy bearings.
Turpentine	For thinning paint.
Clock	For bearings of sights, position-finders, etc.
Graphite	For use on heavy bearings in connection with No. 4½ lubricant, proportion 5 per cent graphite to 95 per cent lubricant by volume. Also for use on gas check pads, proportion 50 per cent graphite and 50 per cent lubricant by weight.

Oil, except in oil holes, is applied with a brush; it may be removed either with a scraper or with waste saturated with kerosene.

All bearings and bright parts should be kept lubricated so as to prevent rust. Before oiling an oil hole, wipe off all dirt or grit near the opening that might be carried into the bearing by the oil.

In general, three coats of paint are given guns and carriages the first year, and thereafter two coats per year. All parts, except bronze trays, breech mechanisms, bearing surfaces, handles of hand-wheels, stuffing box followers, grease cups, scales, and name plates, are painted. Guns are painted gray, or other color for invisibility; carriages are painted green.

When the paint begins to peel off, it should be removed before a fresh coat is applied. Old paint can be removed by a scraper after a mixture of hot lye and lime has been applied and has dried; several applications may be necessary.

Rust is removed by emery cloth—sandpaper must not be used.

Tactical numbers are given guns and mortars. Guns are numbered from right to left, the numbers being placed on the gun or carriage. Mortars are numbered as follows: The right rear mortar, No. 1; right front, No. 2; left rear, No. 3; left front, No. 4; the number being placed on the face of the breech. The right pit is lettered A, and the left B; these letters being placed on the median line of the front wall.

Batteries are "in service" when used at daily drill, and "out of service" when in the hands of caretakers. A battery is "out of commission" when in an unserviceable condition. All batteries ready for use are "in commission," whether "in service" or "out of service."

The habitual position of guns on disappearing carriages is "from battery"; on other carriages, they will be given an elevation of 5°. Breech covers are kept on. Mortars are kept with the axis of bore parallel to the piston rods, breech cover off, and translating roller in place; where snow and ice may form, or sand blows, they are kept horizontal with breech cover on.

Electrical Equipment. All motors on gun carriages should be operated weekly to insure their being kept in order. Bearing parts should be oiled and moisture which accumulates in motor casings should be removed frequently. Cables, whether for light or power, should be protected from injury. The following precautions should be observed.

(1) Before tripping the gun, make sure that the retracting cables are detached from the gun lever hooks.

(2) Before starting motor, take up all slack on the cables, observing that they lie in the proper grooves. (The same precaution should be observed when retracting by hand.)

(3) Hand cranks should be removed, as they rotate with considerable speed and might injure cannoneers.

(4) Do not start motor until gears are in mesh and levers pinned in place. Never move lever while motor is running.

(5) In starting motor, the controller handle should be passed from notch to notch only when motor has speeded up.

(6) Do not operate motor at full speed near the limits of retraction, for fear the gun levers may strike the buffers. Slowing down is accomplished by moving the controller handle to an intermediate position (for a few seconds only); for a slight motion the controller handle is moved to the first notch and then back again quickly.

(7) When through retracting, the switches should be opened and the controller handle kept on the "off" position. *Never* close switch unless controller is in the "off" position.

(8) All electrical contacts must be kept free from oil; when excess sparking at commutator or contacts occur, the trouble should be investigated by an electrician.

The ammunition service apparatus (trolleys, blocks, motors, and hoist) should be operated weekly, and all parts cleaned and properly oiled. Care should be exercised particularly in the handling of projectiles to prevent jamming. The Taylor-Raymond hoist can be used for lowering projectiles *by hand-power only;* the Hodges hoist must *never* be used for lowering projectiles.

CHAPTER V.

FIRE CONTROL APPARATUS.

ANEMOMETER.

41. This instrument consists of four hemispherical cups mounted on a vertical spindle so as to revolve under the action of the wind. A stop watch is started and stopped electrically (or by hand) at successive signals from the instrument, and the velocity of the wind in miles per hour is indicated in red figures on the watch. A mean of five readings is taken as the velocity.

ATMOSPHERE SLIDE RULE.

42. This device is used to determine the atmosphere reference number for the range board by applying the barometer and thermometer readings thereto. Such reference number denotes the relative condition of the atmosphere as regards its density (thickness) compared to another atmosphere which was taken as normal. The rule also includes a scale showing how muzzle velocity is affected by the temperature of the powder. (See paragraph 111.)

BAROMETER.

43. The barometer expresses in inches and hundredths of an inch the height of a column of mercury which the pressure (weight) of the atmosphere forces up a tube exhausted of air.

There are two kinds of barometers: mercurial and aneroid. In the mercurial barometer the column of mercury is actually used and is measured; while in the aneroid barometer a thin metal box exhausted of air is used instead, the change in the box on account of the change in the air recording with a pointer. The aneroid barometer is generally used, the mercurial being used only to adjust the aneroid.

COMMUNICATIONS AND EQUIPMENT.

COMMUNICATIONS.

44. Telephone lines from the fort commander's station to the following: F. C., meteorological, and tide stations; searchlights; and post telephone switchboard.

Telephone lines from the fire commander's station to the following: Fort commander's station; B. C. stations; searchlights of fire command; post telephone switchboard; also from fire command plotting room to fire command observing stations.

Telephone lines from B. C. station to F. C. station; to all battery observing stations, and to plotting room when not adjacent thereto (called "intelligence line").

Telephone line from plotting room to each battery observing station (called "data line"), and to the B. C. station when not adjacent thereto.

Telephone line, speaking tube, or transmission device, from plotting room to emplacement platforms or pits (called "gun line.")

For mortars there are in addition: a telephone line, speaking-tube or zone signal line from the plotting room (or from the booth) to the magazines and galleries, and a telephone line or speaking tube and pit firing system from the pits to the station where the battery commander is located.

FIRE CONTROL EQUIPMENT IN STATIONS.

Fort Commander's Station (C): Telephones with switch-key set (and speaking tube to booths); D. P. F.; observation telescope; searchlight controllers; general defense plans; battle chart, showing areas covered by the different fire commands; table of salvo and datum points; harbor chart, showing location of subareas, searchlights, and searchlight areas.

Fire Commander's Station (F'): Telephones with switch key set (and speaking-tube to booths); D. P. F.; observation telescope; T. I. bell; searchlight controllers; general defense plans; battle chart, showing areas covered by the different batteries; table of salvo and datum points; harbor chart, showing location of subareas, searchlights, and searchlight areas.

Battery Commander's Station, guns (B. C.): Telephones; azimuth instrument or telescopic sight on azimuth instrument base; T. I. bell; stop watch; megaphone; general defense plans; table of salvo and datum points; range table.

Battery Commander's Station, mortars (B. C.): Same as gun battery, and, in addition, a time azimuth device and a pit firing system.

Observing Station (B', B'', F'', etc.): Telephones; D. P. F. or azimuth instrument; table of datum points; chart showing subareas

Plotting room, fire command (P): Telephones; stop watch; plotting board; prediction scale and set-forward rule (or predictor), table of salvo and datum points.

Plotting room, guns (P): Telephones; stop watch; plotting board; prediction scale and set-forward rule (or predictor); deflection board, range board, wind component indicator; atmosphere rule; table of salvo and datum points, muzzle velocity chart.

Plotting room, mortars (P): Telephones, stop watch; plotting board; prediction scale and set-forward rule (or predictor); deflection board; table of salvo and datum points.

Emergency Station (E): Self-contained range finder; stop watch; megaphone; table of salvo and datum points; range table.

Meteorological Station (M): Telephone; barometer; thermom-

NOTE.—Of the equipment enumerated, T. I. bells, telephones, and all equipment in meteorological station are Signal Corps property; harbor charts, speaking tubes, controllers, and tide gauge are Engineer Department property; all other instruments are Ordnance Department property.

eter; wind vane; anemometer; atmosphere slide rule; stop watch.

Tide Station (T): Telephone; tide gauge.

DEFLECTION BOARD (GUN).

45. A device by means of which corrections for wind and drift (and also, when using Case I or II, travel during time of flight) are added algebraically and a reference number called "deflection" (or "azimuth correction" in Case III) obtained. This number is set off on the sight in Case I and II, and on the gun arm azimuth correction device in Case III. There are leaf range scales, T squares, and wind scales for service and subcaliber projectiles.*

OPERATION IN CASE I AND II:

(1) Set wind arm to deflection component indicated by the wind component indicator;

(2) Set platen so that leaf range scale at corrected range intersects right edge of wind arm;

(3) Set right (straight) edge of travel arm on circular scale to denote travel of target during observing interval (30 seconds);

(4) Set T square at corrected range to intersect right (straight) edge of travel arm; on the deflection scale or auxiliary scale is then read, at left edge of T square, the deflection to be used on the sight or sight bracket.

OPERATION IN CASE III is the same, except that the T square is set normal (travel zero) and the azimuth correction for the gun arm azimuth correction device is read on the azimuth correction scale or on auxiliary scale, these scales being set normal except when applying a correction. (In this case the correction for travel was made on plotting board when the set-forward point was located, the gun being fired on bell.)

To apply an arbitrary correction, numbers 2, 3, 4 are placed on the azimuth correction (sliding) scale below 14, 15, 16, respectively; or the auxiliary scale may be used, numbers 14, 15, 16 being placed under 2, 3, 4, respectively. The arbitrary correction is obtained from the B. C. instrument. (See paragraph 121.)

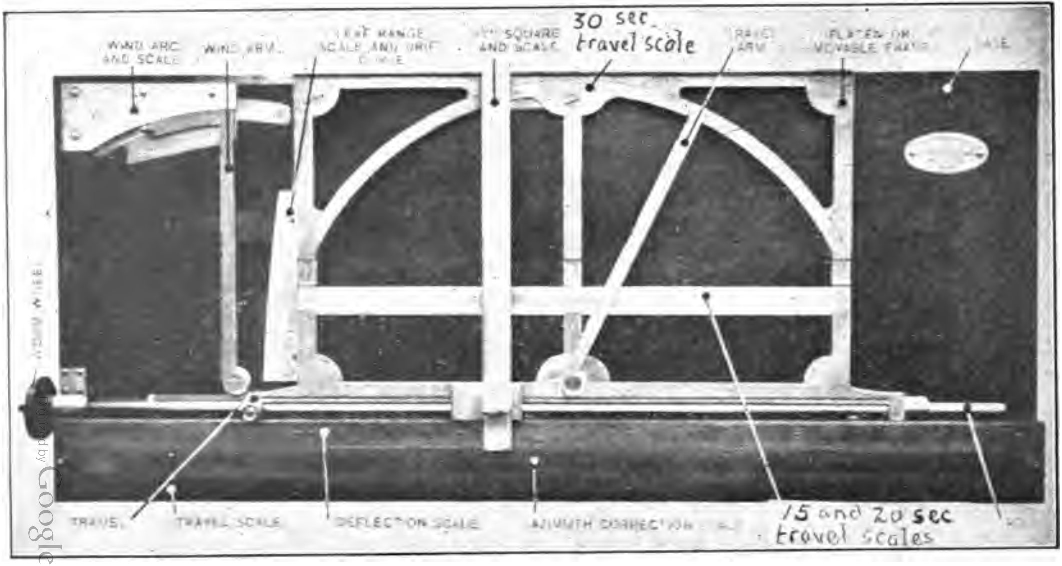
PROBLEM (Using deflection board): Corrected range 5175; travel 14.10, wind reference number 52; answer, deflection would be 2.64 and azimuth correction in Case III would be 14.88 for 10-inch gun, 604-pound projectile.

DEFLECTION BOARD (MORTAR).

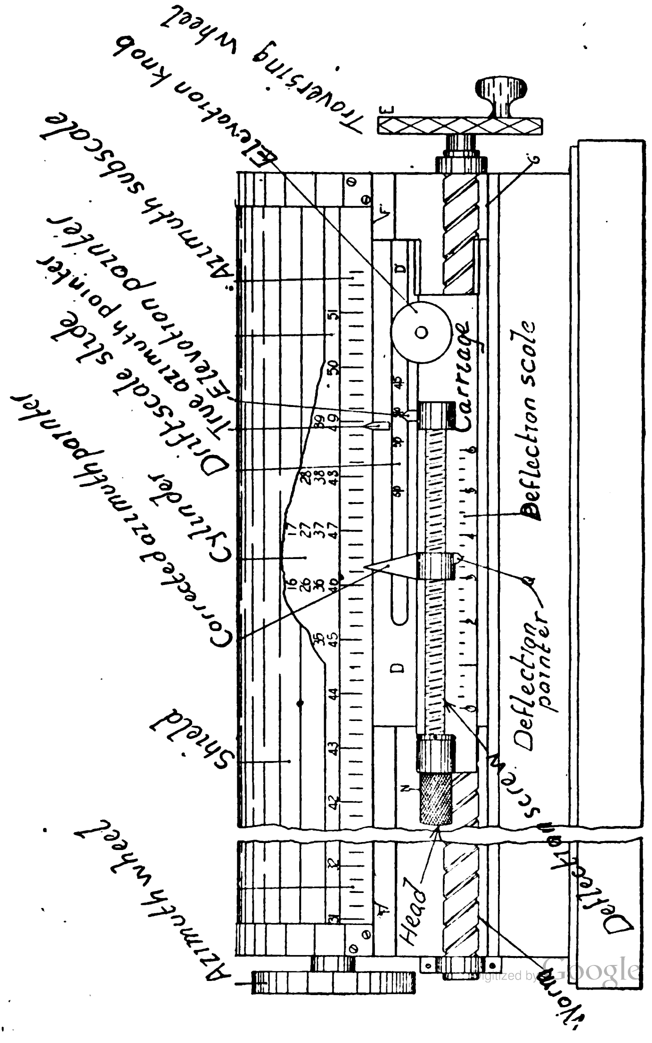
46. A device by means of which the azimuth of the target, or set-forward point, is corrected for drift and other causes. The principle of the board depends on the theory that for a particular

---

*NOTE.—Leaf range scales and T squares are, on the new model deflection board, called "drift scales" and "range-time scales."



GUN DEFLECTION BOARD.



MORTAR DEFLECTION BOARD.

projectile the angular drift is the same at a given elevation whatever the zone or muzzle velocity; consequently there are drift scale slides for the different projectiles.

Operation:

(1) Set the pointer to the elevation determined from the zone scale of the plotting board, or from the elevation board;

(2) Rotate the cylinder until the azimuth of the set-forward point, in degrees, is shown in the right half of the slit;

(3) Set the pointer attached to drift scale to the azimuth of the set-forward point: the corrected azimuth pointer on the left will then indicate the corrected azimuth of the set-forward point to be used in the pit.

The deflection scale pointer is kept at 3 unless a correction is to be made, the correction being obtained from the B. C. instrument as explained in paragraph 121.

On deflection boards which have the chart (DeCarré) substituted for the drift slides the operations are as follows: The chart is rolled until the normal drift for the projectile to be used is under the pointer; the elevation pointer (3) is then set to the elevation, and the azimuth pointer to the actual azimuth; the pointer on left will then indicate the corrected aimuth. An arbitrary correction is applied by setting the pointer to the elevation at which it is desired to make the correction, and then rolling the chart until this elevation line is opposite the correction reference number on elevation pointer; the chart is then used in this position, the pointer (3) being then set at the elevation to be used.

Problem (Using deflection board): Azimuth of target 280; elevation 60; arbitrary deflection correction 3.45; answer, corrected azimuth would be 275.50 for 1046-pound projectile.

The board is tested for accuracy by the use of the test points A, B, and C, stamped on the cylinder, deflection scale, and drift scale slide; the pointers are set on corresponding points (A) and the corrected azimuth pointer should indicate the azimuth stamped on the drift scale slide (opposite A).

DEFLECTION RECORDER'S BOARD.

47. The deflection recorder (member of gun section) records on this board in figures about 8 inches high the deflections sent from the plotting room, erasing the last ones recorded where necessary.

In Case III the azimuths will be recorded instead.

INDICATION AND IDENTIFICATION OF TARGETS.

48. The water areas of harbors are divided into subareas by the coast defense commander and each given a name.

A target is indicated as follows, the dash denoting a pause in the command so the operators can 'phone the words preceding:

TARGET——NORTH——STEAMER COMING IN (or **BATTLE-SHIP DIVISION, SHIP NUMBER ONE——**, or **CLASS FOUR TWO,** etc., etc.)——**TRACK.**

EXPLANATION: The first command **TARGET** serves to call the details to attention.

The second command gives the subarea which contains the target; the observers and gun pointers traverse to the direction indicated.

The third command describes the target. No exact system can be prescribed, except that as few words necessary to accurately identify should be given. The leading ship in column or starboard (military right) is number one. The first figure after **CLASS** denotes the number of funnels; the second, the masts.

When the observers and gun pointers are on target, they report **B′** (**B″** or **No. 1,** etc.) **ON TARGET;** the battery commander then gives the fourth command, **TRACK.** This command refers to the system generally used (*i. e.*, horizontal base), the words **VERTICAL BASE,** etc., being employed for other cases. To change from one system to another, command **VERTICAL** (or **HORIZONTAL,** etc.) **BASE, TRACK.**

To change to another ship in the same division, commands **CHANGE TARGET——SHIP NUMBER TWO.**

The forward funnel of steam vessels and the forward mast of sailing vessels will be observing and aiming points, respectively, for observers and gun pointers; for other targets and when conditions require, the point will be designated by the battery commander before his command **TRACK,** as **OBSERVATION ON SECOND MAST,** etc.

To identify a target, the command **B′** (or **B″**) **DESCRIBE** is given, at which command the observers concerned, without ceasing to track, give a full description of the target; if satisfactory, the signal **ON TARGET B′** (**B″**) is given by the battery commander. Target may similarly be identified by gun pointers.

Fire commanders indicating targets use similar commands, preceding, however, with the words **ALL BATTERIES** (or name of battery, as **EUSTIS**): this serves to call the battery to attention. At night the number of the searchlight covering target, as **IN FIVE,** may also be used. The target may also be indicated by the F. C. station tracking and locating a predicted point, the relocated azimuth and range of which is set off on the B. C. instrument; the signal **NOW** is given when the target crosses the wire of the F. C. instrument, at which instant it should also be found in the B. C. instrument. Targets may also be indicated and identified by a system of squares.

MUZZLE VELOCITY GRAPHIC CHART FOR GUNS.

49. A chart to determine, from firings of trial or other shots, the muzzle velocity to be used for record shots.

Operation:

(1) Set the T square so that the curve corresponding to the actual range of the target for trial shots intersects at the velocity assumed: the velocity for record shots will then be found on the T square at its intersection with the curve which represents the actual range to center of impact of trial shots.

MUZZLE VELOCITY CHART FOR MORTARS.

50. A chart to determine from firings of trial or other shots, the muzzle velocity to be used for record shots. It consists of a series of zone lines on which are marked ranges and corresponding muzzle velocities, and a string or ruler attached to a pivot.

Operation: Having determined the range to a shot, or center of impact of shots fired at the same elevation with the **same powder,** set the ruler to this range; the intersection of the ruler with the various zone lines will then indicate the muzzle velocity for the various zones for this particular blend of powder. The points of intersection also indicate ranges to temporary indices to be marked on ruler of mortar elevation board.

The chart may be similarly used to make range corrections from observation of fire.

MORTAR RANGE-ELEVATION BOARD.

51. This consists of a chart on which are drawn elevation and time of flight curves and velocity zone lines. A range ruler, adjustable both up and down and across and containing a pointer, is mounted across the chart. A slide for obtaining time of flight is also attached.

Operation of a Board Designed by Lieutenant DeCarre:

(1) Set the ruler to the zone or muzzle velocity determined from the muzzle velocity chart;

(2) Adjust zone index of ruler to the 59° line (when velocity is not normal, as determined from the trial shots, use a temporary index placed on ruler opposite range to center of impact);

(3) Set pointer to range of target or set-forward point; and

(4) Read the elevation on chart opposite pointer.

(5) The time of flight for the next set-forward point is predicted (for use of the plotter) by means of a celluloid slide which has an arrow at one end. At each reading of elevation the arrow, remaining at the range to last set-forward point, a pencil mark is made on the slide, thus indicating the travel between the two points; the arrow is then brought up to the range of the set-forward point and the time of flight is found opposite the pencil mark, which is then erased.

(6) When the set-forward range is about to pass off the elevation curves, the ruler is set to the next zone or muzzle velocity line as in (1), and that zone index (permanent or temporary) set to the 59° line as in (2). The operation then continues as described.

PLOTTING BOARD.

52. The plotting board is a representation on a reduced scale of the surface of the earth—normally, 1 inch on the board representing 300 yards on shore or water. A board is used right-handed when the secondary station block is to the right of the center of the board; left-handed when to the left. The primary arm is always pivoted about the primary station block at the geometrical center of the board, though the corresponding observing station on shore may be called B″ or B‴. Boards issued for right-hand base lines have the arms graduated on the right-hand edge, facing the field of fire; such boards could be used left-handed, but would be awkward for plotting, consequently in such cases arms graduated on the other edge would be requisitioned for. Station blocks graduated for right-hand base lines could be used for left-hand base lines, but the numbers would have to be reversed—*i. e.*, the zero would be where the 25 is stamped.

In verifying the orientation of the board, first orient oneself on land so as to get a mental picture of the location of the base end stations in relation to the battery, and make sure that the proper telephones go to the proper readers.

The azimuth and length of the base line and rectangular coördinates of the directing point are obtained from a survey and are recorded in the emplacement book and in the office of the artillery engineer. By rectangular coördinates is meant the perpendicular distance of the directing point in front or rear of the base line (called "longitudinal"), and the distance to the right or left of the primary block measured along the base line (called "lateral").

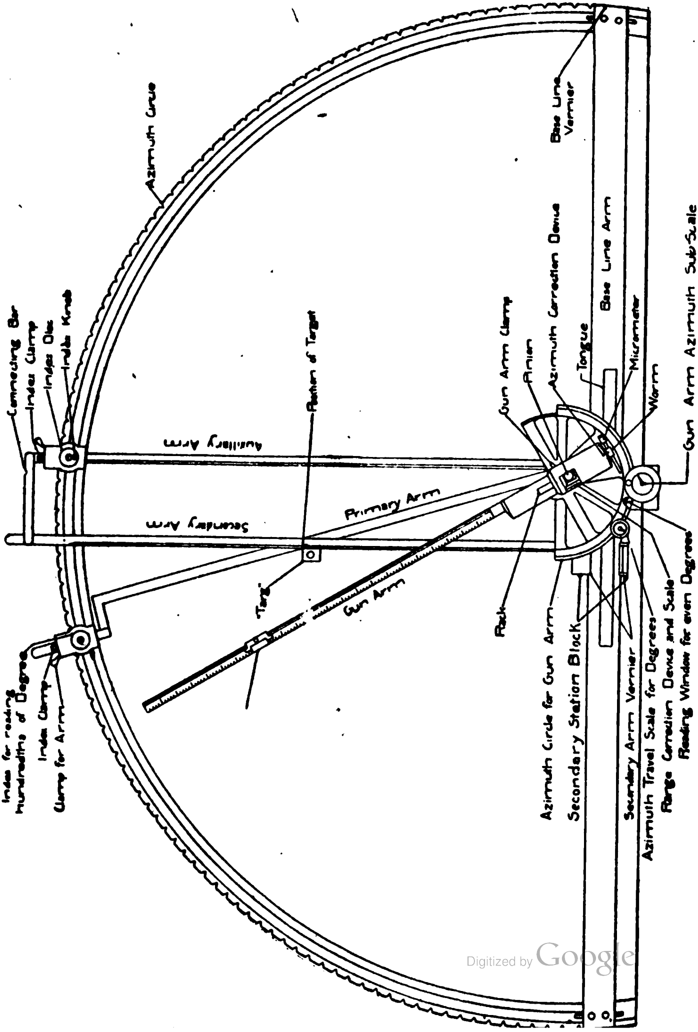
The normal line is the radius of the board at right angles to the base line when the verniers at each end of the base line arm are set at zero. The azimuth of the normal line is found by subtracting 90° from the azimuth of the base line (hundredths neglected) for a right-hand board, or by adding 90° for a left-hand board (hundredths neglected).*

The gun arm is always set at 2,000, except that in subcaliber work it may be drawn in for convenience in plotting, and a separate scale attached. For subcaliber practice the scale of the board may be increased to 1 inch = 100 or 150 yards, the proper corrections being applied to all linear scales on base line arm, gun arm center, all arms, and another coupler substituted.

Near the outer circumference of the board is sometimes drawn a diagonal scale to be used by the gun arm for determining the azimuth of the predicted point in Case III for guns, and for setting

---

*NOTE.—An alternative method of determining the normal line for orienting the board is to take the next full degree, when the hundredths are more than 50, and afterwards rotating the base line arm contra-clockwise the hundredths it falls short of the degree taken. In checking the orientation of the board, both methods should be tried out before the graduated strips are changed.



GUN PLOTTING BOARD.

off azimuths. This scale should be drawn for the primary or secondary when these stations are used as B. C. stations. They consist of two concentric circles several inches apart, drawn with the proper station as a center, degree marks being established by the proper arms; diagonal lines connect the outer and inner adjacent degree marks, and the interesection of the arm, on which a scale is attached, with the diagonal determines the azimuth (on some the space between the two circles is divided by several circles).

Index boxes are marked for the proper arms. They are assembled with the disk set at 50 and the pinion and rack in mesh at 0 (marked on the pinion and rack), and then slipped on the arm and azimuth circle when the arms are near the ends of the base line arm. Screws for limiting the lateral motion 0 to 99 are provided. One index box is marked "Prim. R. Aux. L." and the other is marked "Prim. L. Aux. R."; the former goes on primary arm when the board is used right-handed, the latter on primary arm when used left-handed. The remaining box goes on the auxiliary arm.

To Orient Board:

(1) Clamp primary arm on normal line, the index disk being at zero, so that its reading edge extended would pass through the middle notch, determined by counting (letter N stamped on some boards) of the azimuth circle;

(2) Number clockwise, or set in the graduated strips so that the arrow of index box points to the azimuth of normal line;

(3) Clamp auxiliary arm, the index disk being at zero, over primary arm, and number clockwise, or set in graduated strips so that arrow of secondary points to (on outer circle) the same azimuth as the primary;

(4) Set secondary station block to length of base line, and connect secondary and auxiliary arms with a coupler having same length as base line;

(5) Rotate base line arm clockwise from its zero position an amount equal to hundredths (only) of base line azimuth, and clamp both ends (see, also, alternative method);

(6) Set longitudinal and lateral adjusting slides at zero; set gun arm over primary arm, using targ, and number contra-clockwise, or set graduated strips in gun arm azimuth circle so that the gun arm will read the same azimuth as the primary; the degree pointer can be adjusted laterally, and the subdial either by rotation or shifting the arrow;

Note.—When the azimuth and range of the directing point from primary is known, an easier method of orienting gun arm than described under (6) is as follows: (1) Set primary arm to azimuth, or back azimuth, of directing point from primary, (2) set gun arm over primary, using targ, and then (3) adjust graduated strip of gun arm azimuth circle, and subdial, to read this same azimuth. The difference between the gun arm range and primary arm range should equal the distance between the primary station and directing point.

(7) Set gun arm center over directing point by sliding to right or left, front or rear, amounts in yards equal to lateral and longitudinal coördinates of directing point; if graduations can not be seen, remove screws from front end of longitudinal slide and from inside of subdial, and rotate out of the way;

(8) Set gun arm at 2,000 (or for mortars, when elevation board is not used, locate on zone slide a zero opposite the arrow so that the elevations opposite ranges will be as shown on range table, and apply a range correction scale in yards, the minus graduations extending in and the plus out, or reference numbers may be used instead).

To Check Accuracy of Board: Using assumed or known azimuths, plot points in the right, left, and center of the field of fire. The ranges (and also azimuth for directing point) to these three points, measured by the three arms, should be the same as those calculated by trigonometry.

Operation:

(1) Set primary and secondary arms to azimuth of target and plot point of intersection;

(2) Locate the set-forward point when using a moving target as described under "Plotting Room Duties" and Set-forward Rule";

(3) Read range (zone, elevation, and time of flight for mortars when elevation board is not used) on gun arm (which is set at 2,000, except for subcaliber) when the latter is brought to targ placed on point plotted, or on set-forward point when tracking a moving target;

(4) Read azimuth on gun arm azimuth circle when Case III is being used, the azimuth correction device on gun boards being set normal (15), unless a correction is to be made;

(5) Read azimuth of predicted point when Case III is being used, using diagonal scale for guns, and for mortars when B. C. is at primary or secondary;

(6) Set tally dials normal when gun arm is on point, and read angular travel when the gun arm is brought to next similar point, and again set dials at zero.

A **vernier** is a device for reading smaller divisions than are on the main scale. The smallest division read by a vernier is called its "least count," and is found by dividing the smallest division on the main scale by the number of divisions on the vernier. All the verniers on the plotting board, except those at the ends of the base line arms, read to 1 yard; the verniers at the ends read to .01 degree. The position the vernier zero occupies relative to the main scale determines the reading, so it is wise to first approximate before attempting to read accurately. To read vernier: (1) Read the last division on the main scale just passed by the vernier zero, and (2) then add one for every line on the vernier up to that line which is directly opposite a line on the main scale. For example, suppose the vernier zero of secondary station block has passed two divisions beyond 2,000 and the seventh line on vernier is directly opposite a line on base line arm; to find the setting (which is obviously between 2,050 and 2,075), read 2,000 + 50 + 7 yards. Again, suppose the vernier zero at end of base line arm has passed .70 and the eighth line of vernier is opposite a line on base line azimuth scale; to find the setting (which is obviously between 70 and 80), read 70 + 8 = .78 degree.

53. **The Fire Commander's Plotting Board** differs from other plotting boards in that it has a movable gun arm center, which is operated by a pantograph attachment. A templet is constructed (60 yards = 1 inch) with holes to represent to this scale the stations of the batteries of the fire command. With the stylus plugged in a station hole, the gun arm brought to any point reads the range and azimuth of that point from the station plugged in. The assembling, adjustments, and orientation are similar to those of other boards. The gun arm azimuth circle is oriented by plugging in the stylus at F′, bringing the gun arm over the primary arm, and setting the circle to read azimuth of index box. With this board a point can be plotted by any battery and its range and azimuth determined for any other battery, as required in the firing of trial shots.

54. **360° Mortar Plotting Board:** This board is in general similar to the other boards, with the following differences: the board is a complete circle; the station farthest from the directing point of the battery is usually located at the center of the board; several base lines may be used; the gun arm is provided with a sliding range scale, by means of which flat range corrections may be made from the normal position of 2,000, and is attached to an auxiliary arm centered at the center of the board, from which azimuths are read (actual and corrected) at the outer circumference of the board, there being drift and arbitrary correction scales thereon.

The board is in general set up, oriented, adjusted, and tested for accuracy like other boards.

To Use the Board: The base line arm is rotated until the indices at the ends are opposite reference lines indicating the base line to be used; the movable arm bracket (station block) is set for the length of the base line, and the gun arm center located with reference to this base line; proper couplers for gun and primary arms are attached; plotting is done as on other boards. In shifting to another base line, the same operations of orienting and adjusting the base line and directing point are repeated.

Note.—A 110-degree plotting board, permitting the quick shifting from one base line to another, is being constructed for issue.

A scale of 500 yards is now being used on boards for major armament; if all graduations have not been changed, settings of base line and slides equal to three-fifths of the actual data must be used.

PLOTTING ROOM DUTIES.

GUNS (CASES I AND II).

55. Nos. 2 and 3 set arms at azimuths received from observing stations, lock index boxes, call "Set," and move arms back when directed.

The plotter with targ locates plotted point at intersection of arms (or at range called out when vertical base is used). When the plotter has three plotted points, he places prediction scale along course, the zero on last plotted point, calls travel over observing interval (30 seconds), and locates set-forward point at travel during the predicting interval plus time of flight, which is called by operator of set-forward ruler (or the predictor may be used); the gun arm is then brought to the targ, placed on the set-forward point, and the plotter reads the range to targ.

No. 1 operates tally dials and calls angular travel, first between two successive plotted points and thereafter between two successive set-forward points; he also operates wind component indicator, keeping arm set to within 2½° of azimuth of set-forward point.

No. 4 sets ruler of range board to the actual range called out by plotter, applies the corrections, and telephones the corrected range to the guns; he also repeats to the guns the deflection called out by No. 5; he also checks up the atmosphere reference number by applying the barometer and thermometer readings to atmosphere slide rule.

No. 5, using last corrected range, determines the deflection from the deflection board and calls it to No. 4. Angular travel may be obtained from the tally dials, or from a slide rule constructed to give proper reference numbers corresponding to two successive azimuths of the target, obtained from an observing station near battery, or from the gun arm; more accurate results are obtained by using a mean travel over several intervals.

No. 6 operates the transmission device, if one is installed, or the time-range chart, if used.

GUNS (CASE III).

The operations are as explained, except that a predicting interval of 60 seconds is used; the plotter reading the travel over two observing intervals and plotting the predicted point 60 seconds in advance of the last plotted point, and the set-forward point at travel called by operator of set-forward ruler.

No. 1 calls the azimuth of the set-forward point to No. 4, and operates the wind component indicator.

No. 2 also calls the azimuth of the predicted point to the B. C. station.

No. 4 operates the range board, and calls range and azimuth to guns.

No. 5 determines azimuth correction (instead of deflection) and sets it on the gun arm azimuth correction device.

MORTARS.

56. Nos. 2 and 3 set arms at azimuths received from observing stations, lock index boxes, call "Set," and move arms back when directed.

Predictions are made, generally, every minute, and, if the directing point is a pit, they are for alternate pits; in this case, the data for the non-directing pit has to be corrected for pit difference before being transmitted.

The plotter locates plotted point at intersection of arms (or at range called, when vertical base is used). When the plotter has three plotted points, he estimates the location of the set-forward point by running up mortar arm, and calls out from zone slide the zone number and the time of flight; on the next plotted point he places the zero of the prediction scale, calls travel over 60 seconds, and plots the predicted point 60 seconds ahead, and the set-forward point at travel called by operator of set-forward ruler (or the predictor may be used); he brings the mortar arm to the set-forward point and calls elevation to No. 4, after which No. 1 calls azimuth to No. 4; the proper arm is then brought to the targ placed on the predicted point, and the azimuth called to the B. C. station by Nos. 1 or 2. The zone, elevation, and set-forward azimuth are also sent to the B. C. station.

No. 4 calls to the pits **"A Pit"** (or **"B"**) and repeats the zone number and elevation; he also operates the deflection board and sends the corrected azimuth to the pits.

In batteries which use an elevation or range board, the operator wears the head set to the booth. In this system the zone scale is removed from the mortar arm, the plotter reading the **range** to the set-forward point. The elevation board operator sets the pointer to the range of the set-forward point, and reads the zone and elevation.

The azimuth keeper (in B. C. station) operates the time-azimuth board or blackboard, and calls **ERROR** if any occur.*

VERTICAL BASE, GUNS AND MORTARS.

The operations for vertical base, gun or mortar, are the same, except that the range officer switches both arm setters across the line to observing station selected; the arm setter bridged in calls the range as soon as the regular arm setter has set the azimuth and called "Set."

POSITION FINDING (TELESCOPIC) INSTRUMENTS.

57. CARE: These instruments must not be subjected to jars

---

*NOTE.—All data used in the pits must be checked in the B. C. station with data received from plotting room, before the command for firing is given. If there is a discrepancy which can not be corrected in time, or if the target does not cross vertical wire of B. C. instrument, which has been set at predicted azimuth, withing five seconds of bell, the battery commander commands **RELAY**, which command requires a new prediction.

or other rough usage, must not be taken apart, and must be protected from dust and moisture. The lenses should be cleaned only with soft, clean paper or cloth. Clock oil only is used on bearings. To guard against injury and the wear which might cause inaccuracy the metal parts of these instruments are kept clean, but are **not polished.**

DEPRESSION POSITION FINDERS measure vertical angles of depression and indicate ranges corresponding to the angles measured; they also measure azimuths.

TO FOCUS: A telescope is focused as follows:

(1) Focus the eye piece until every roughness of cross wires is seen;

(2) Focus objective until parallax is removed and the object clearly seen; parallax is removed when the object does not move off wire as the eye is moved across eyepiece.

It is not always easy to determine when the eyepiece is properly focused, and as a result, when the parallax is removed, the object appears indistinct. In such cases an adjustment (by trial) is necessary, as follows: With eyepiece screwed home, focus objective and test for parallax, then unscrew the eye piece about one-eighth turn and refocus objective, continuing until the object, when well defined, is without parallax. The eyepiece adjustment is a personal adjustment independent of range, while the objective adjustment depends on the range.

TO LEVEL INSTRUMENTS WHICH HAVE FOUR LEVELING SCREWS:

(1) Set one of the levels over two (diametrically) opposite leveling screws;

(2) Turn the opposite screws in opposite directions until the bubbles of both levels (the bubble follows the direction of left thumb) are in the middle, being careful to maintain a firm bearing of the screws on the plate, but not to force them;

(3) Traverse instrument 180°;

(4) If bubbles can not be made to remain in same position when instrument is traversed, it is because the levels are out of adjustment, in which case the instrument is brought to level, one-half by the leveling screws and the other half by the adjusting screws on level.

Instruments which have only three leveling screws (Lewis) are leveled over two leveling screws (traversed 90° if only one level is on the instrument) and leveled with the third screw; then traversed 180° to verify level. In order that all three screws have a firm bearing without jamming, it is frequently found that when leveling with the third screw it may be necessary to screw both of the other screws in or out.

TO USE THE INSTRUMENT: Follow the target in azimuth with the horizontal wire just below the water line and the vertical wire on the point of observation and stop the instrument on the last stroke of the triple stroke bell until the azimuth is read. When using vertical base, the target should, in addition, be water lined at the first stroke of the bell by bisecting the bow wave, or stern, and the range read after the azimuth. When the last direction of motion in azimuth is not the same as that used when orienting, the back-lash should be removed by reversing the azimuth hand-wheel before the azimuth is read. The adjustments should be checked frequently. No part of the head or body at any time should rest against the instrument.

DATUM POINTS: The azimuth and range to different datum points are determined from a survey and are recorded in the emplacement book and artillery engineer's office; where no fixed datum points are established, buoys can be used. Data for orientation should be posted in each station.

OBSERVER'S TEST: Two instruments set up side by side and observations taken on moving target at regular intervals, and the readings compared; for a D. P. F. the ranges, in addition, are compared with those obtained from the horizontal base. The errors should not exceed, for azimuth ± .02°; and for range ½ per cent of the range within 12,000 yards for distances equal to 1,000 yards for every 10 feet height of instrument above water.

LEWIS D. P. F., TYPE A, MODEL 1898.

(Used for Azimuths only.)

58. Adjustments:

(1) Focus telescope;

(2) Orient by setting instrument to read azimuth of datum point, loosen set-screw in column, turn the table until vertical wire is on datum point, and clamp set-screw;

(3) Level;

(4) It may be necessary to orient and relevel.

LEWIS D. P. F., MODEL 1907.

59. Adjustments:

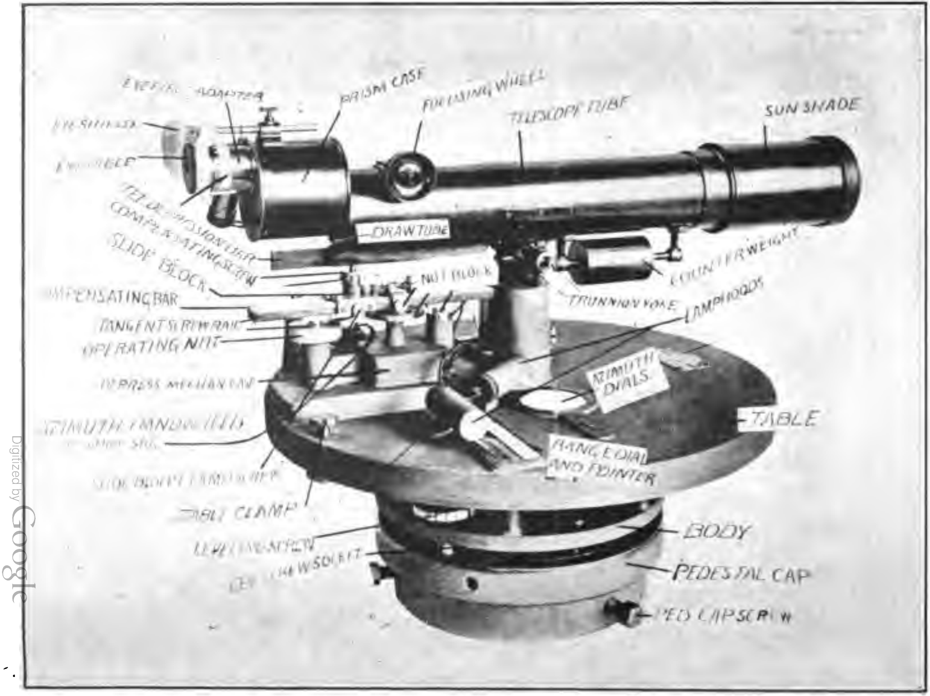
(1) Focus telescope;

(2) Orient by clamping table to read azimuth of datum point, loosen screws in pedestal cap and turn body of instrument until the vertical wire is on datum point, and tighten screws (azimuth mechanism shipped out of mesh can be adjusted by four screws on top of table);

(3) Level;

(4) It may be necessary to orient and relevel;

NOTE.—The T. I. system should be cut out frequently at drill and a stop watch used, the signals **READY**, **TAKE**, being called through telephones at proper intervals to the observers by a telephone operator at the B. C. station. Large errors in azimuth may be detected in the pit by chalking across racer and floor plate and noting that distances between successive lines are approximately equal.



LEWIS DEPRESSION POSITION FINDER, MODEL 1907

(5) Adjust for range.

The adjustment for range is as follows:

(1) Set the height scale to correspond to height above low water minus present height of tide;

(2) Set instrument to range of long-range datum point, direct telescope on datum point, loosen the clamp screw of compensating screw, water line with the latter, and clamp;

(3) Set instrument to range of short-range datum point, and, if it is not water lined when directed on datum point, change setting of height scale until it is water lined;

(4) Repeat operations (2) and (3), water lining at long range with compensating screw, and at short range with height scale, until the instrument reads correct ranges at both datum points;

(5) Should the error of instrument be greater than one-half of the danger space when directed to a mid-range datum point, the adjustment should be changed so as to distribute the error among the three datum points; this is accomplished by substituting the mid-range datum point for one of the others, and the adjustment repeated.

Azimuths are read by means of two dials and a stationary scale as follows: (1) On the fixed dial read the lesser of the two numbers between which the pointer comes; (2) then read the number on the movable dial which is opposite the hundredth scale; (3) then call "Point" and read the hundredth graduation opposite the movable dial number. To illustrate, suppose the pointer is between 4 and 5, and 2 of the movable dial opposite 31: the azimuth would then be read **four two point three one.**

SWASEY D. P. F.

60. Adjustment:

(1) Focus telescope;

(2) Orient by setting instrument to read azimuth of datum point, loosen azimuth plate bolts if necessary, and turn instrument on base until the vertical wire is on datum point, and tighten bolts;

(3) Level;

(4) It may be necessary to orient and relevel;

(5) Adjust for range.

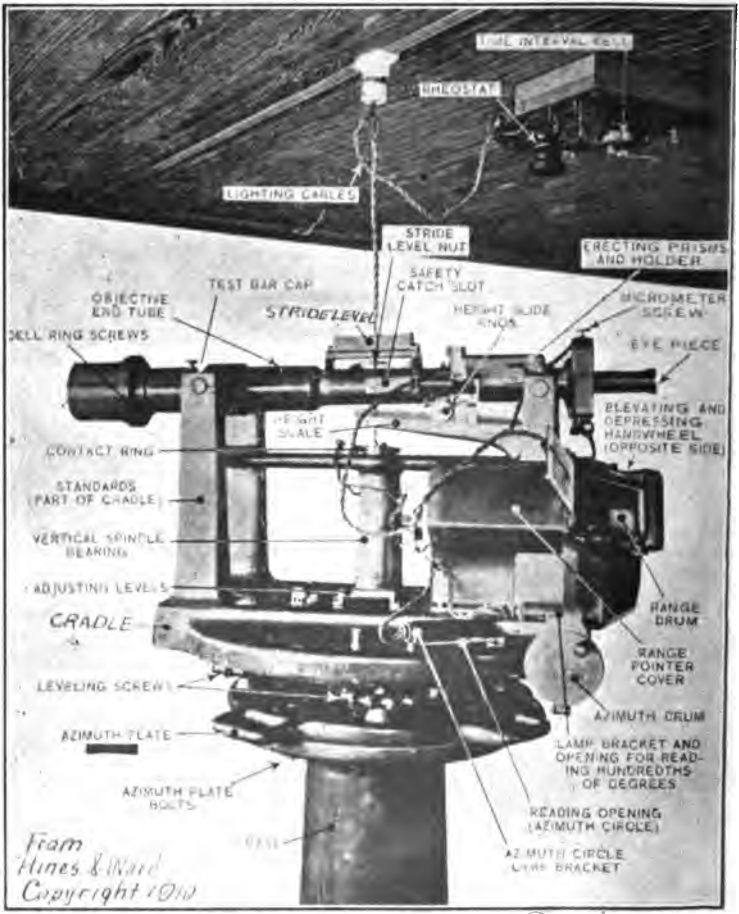
The adjustment for range is as follows:

(1) Set the height scale to correspond to height above low ater minus present height of tide;

(2) Bring telescope to horizontal, using the striding level, and set range drum to read telescope level, loosening the screws if necessry;

(3) Set instrument to range of long-range datum point, direct telescope on datum point, and water line with micrometer screw;

(4) Set instrument to range of short-range datum point, and, if it is not water lined when directed on datum point, change the



SWASEY DEPRESSION POSITION FINDER.

height slide (the reading remaining the same) until it is water lined;

(5) Repeat operations (3) and (4), water lining at long range with micrometer screw, and at short range with height slide, until [illegible] instrument reads correct ranges at both datum points;

(6) Should the error of instrument be greater than one-half [illegible] the danger space when directed to a mid-range datum point, [illegible] adjustment should be changed so as to distribute the error among the three datum points; this is accomplished by substituting the mid-range datum point for one of the others, and the adjustment repeated.

WARNER & SWASEY AZIMUTH INSTRUMENT.

61. To set up and orient instrument:

(1) Remove the instrument from its case, grasping by the table (not by telescope), and screw on pier mount, or tripod;

(2) Set instrument to read azimuth of datum point, making sure the slow-motion screw is about the middle of its play;

(3) Focus telescope;

(4) Set tripod so that plumb bob is over home station, the telescope pointing in the general direction of datum point (on a pier mount the base should be adjusted in azimuth so that the instrument will have the correct general direction when screwed thereto);

(5) Level;

(6) Bring vertical wire on datum point with the slow-motion screw and clamp.

There is no material difference in the two models of azimuth instruments. The 1910 model has additional slow-motion devices, and in mounting its telescope is not attached until the base of the instrument has been set up.*

COINCIDENCE RANGE FINDERS.

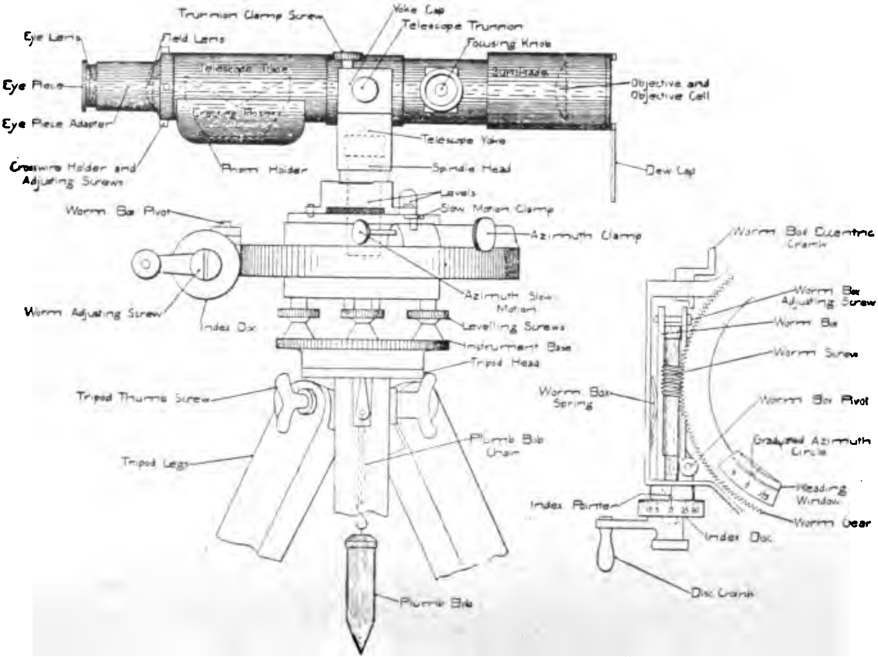
62. These are self-contained range finders, having a horizontal base line of several yards length. A prism at each end of this base-line reflects partial images on the eyepiece prisms: the right prism the upper half of the image; the left prism the lower half. One of these partial images passes through a deflecting prism, which can be moved so as to bring the partial images in coincidence; the instrument actually measures the angle subtended by the base-line at the target, but is graduated on the scale attached to the deflecting prism, in range.

ADJUSTMENTS:

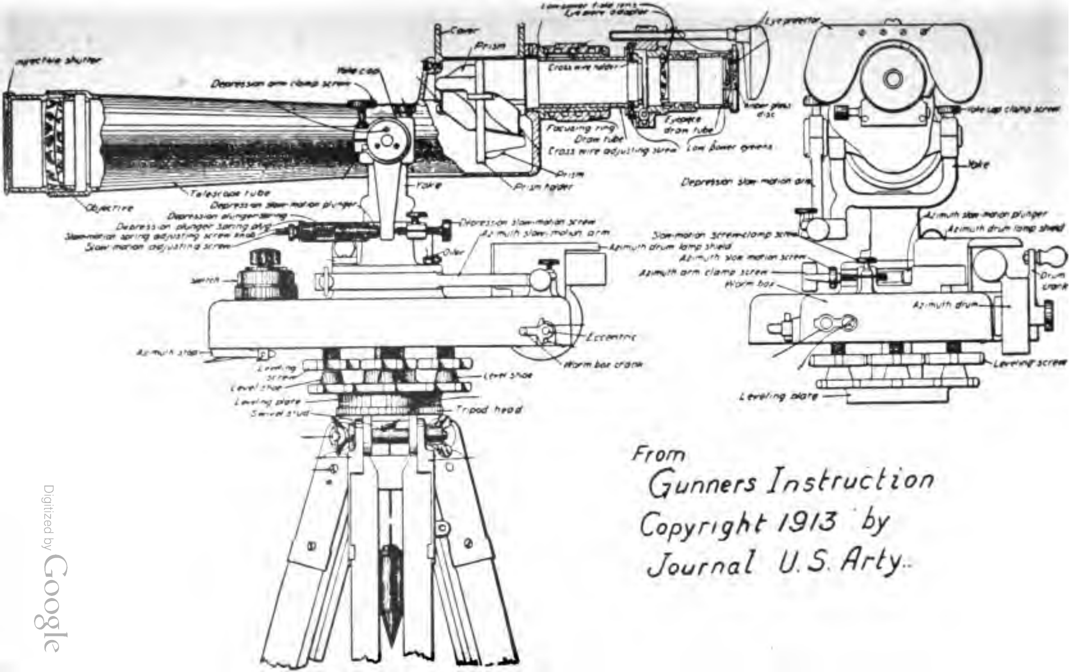
(1) Revolve the seat to accommodate observer, and focus the eyepiece;

(2) Orient by directing to datum point, and, with friction ring, clamping azimuth disk to azimuth of datum point;

***NOTE.—Back-lash or lost motion can be eliminated by the worm box adjusting screw, and longitudinal play of the worm can be eliminated by the worm adjusting screw.**



AZIMUTH INSTRUMENT, MODEL 1900.



From
Gunners Instruction
Copyright 1913 by
Journal U.S. Arty..

AZIMUTH INSTRUMENT, MODEL 1910.

(3) Halving adjustment. Move the instrument in elevation until the image is seen only in lower field; then gradually alter the elevation till the image rises above the separating line. Halving is correct if the top of object appears above the separating line the instant it appears from the lower field;

(4) Coincidence adjustment. This is the adjustment for range. Bring the partial images in coincidence; disengage the deflecting prism gear by moving the coincidence adjusting slider to the left; next, with deflecting head, set scale to read the correct range; then move slider to right to re-engage.

A coincidence (infinity) adjustment can also be made by observing on the moon or a star, the infinity mark on the scale being set opposite the pointer after the images are in coincidence. The astigmatizer is used in this adjustment, or the instrument may be jarred to make the star appear as a streak.

OPERATION: With the elevating and traversing mechanisms bring the target in the fields, first using the finder and sighting over it; then operate the deflecting head so as to bring the partial images in coincidence, and read range (and azimuth if called for).

POSITION FINDING SYSTEMS.

63. The following systems of range finding are in use:

(1) Horizontal base system, which has an azimuth reading instrument at each end of a base line; when a battery has more than one horizontal base, the others are designated "B′ Auxiliary Base" (or "B″" or "B‴ Auxiliary Base"). The auxiliary horizontal base may be formed with the B. C. or with independent stations; in the former case a diagonal scale on the plotting board may be used.

(2) Vertical base system, which requires a D. P. F. in one or more stations.

(3) Coincidence system, which requires a coincidence range finder; if this range finder does not indicate azimuths, a separate azimuth instrument is required.

(4) Emergency system, which may consist of either of the systems specified in (2) or (3), or such other system as may be improvised by the battery commander. This system would be used when the other systems went out of action. The usual method of plotting and predicting, etc., would be followed if practicable. When all communications fail, the improvised system contemplates the use of ranges (or elevations and azimuths) obtained direct from the instrument, without recourse to the plotting room, the necessary corrections for range and azimuth being determined either from improvised devices or from observation of fire.

64. **Salvo points** are imaginary points, the azimuth and range to which are known from batteries, fire and fort command stations;

channel points are similar points in the channel only. They could be used to direct the fire of batteries when the target was obscured from the batteries and stations, and may or may not be obscured from the F. C. station. The approach of a hostile ship would be determined by tracking with F. C. stations if practicable, otherwise by signal from another station or boat. The salvo point number would be sent to the battery in time to have it corrected in the plotting room for range and azimuth, and the command for firing would be given by the fire commander.

PREDICTION SCALE.

65. A scale to measure travel and to locate predicted and set-forward points.

Operation:

(1) Place scale along probable course of target as determined from last plotted points, with zero at last plotted point;

(2) Call travel from plotted point just preceding (second plotted point when, in Case III, an observing interval of 30 seconds is used);

(3) Locate set-forward point at travel, determined from set-forward ruler. In Case III the predicted point is also located (on opposite side of zero) at travel during one minute.

PREDICTER.

66. A device which may be substituted for the prediction scale and set-forward ruler, to determine the predicted and set-forward points.

Operation:

(1) Place the second leg on last plotted point and first leg on plotted point just preceding (second plotted point preceding when, in Case III, an observing interval of 30 seconds is used);

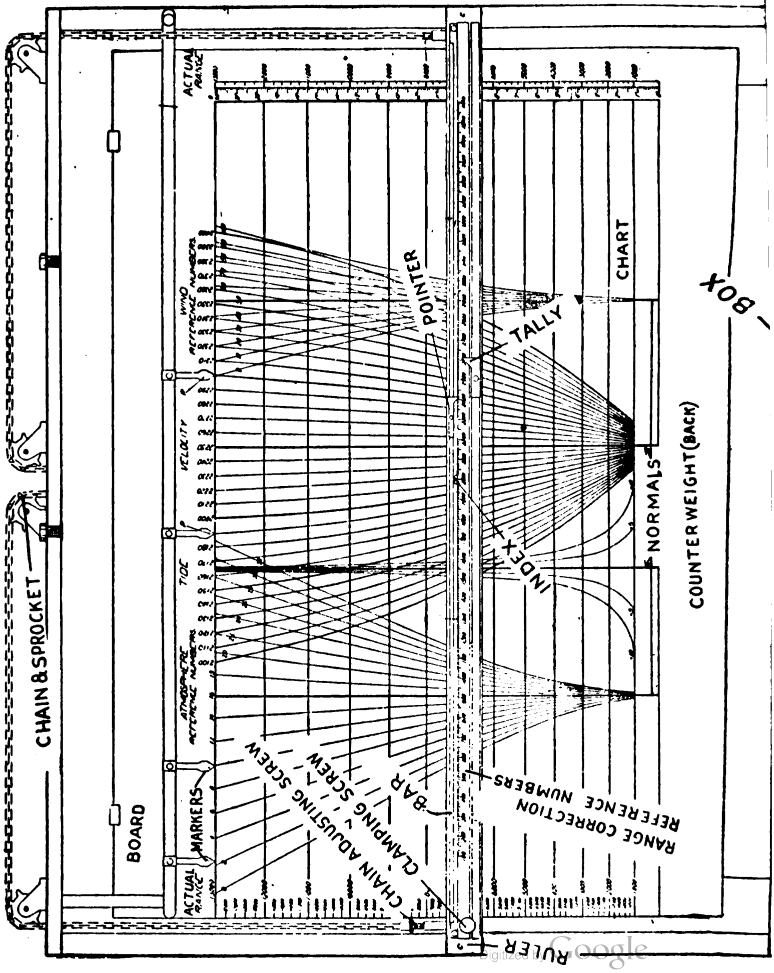
(2) Locate set-forward point at leg corresponding to time of flight;

(3) Locate predicted point at third leg when using Case III.

RANGE BOARD (PRATT).

67. A device for determining the range corrections due to the abnormal state of tide, wind, atmosphere, and muzzle velocity, and adding them to the actual range in order to determine the corrected range for use at the guns. Charts are constructed for different heights of site. A chart for subcaliber work is also furnished, and is usually fastened on the opposite side of the board.

Each of the four pointers of the ruler has three positions: M, S, and L (movable, stopped, and locked); at M it is locked to the movable bar, and moves with it; at S it is locked to the fixed bar, and does not move; at L it is locked to both fixed and movable bars, thus locking the system and preventing any movement.


CHAIN & SPROCKET
BOARD
MARKERS
ACTUAL RANGE
ACTUAL RANGE
WIND REFERENCE NUMBERS
VELOCITY
TIDE
ATMOSPHERIC REFERENCE NUMBERS
POINTER
TALLY
CHART
BOX
INDEX
NORMALS
COUNTERWEIGHT (BACK)
RANGE CORRECTION REFERENCE NUMBERS
BAR
CLAMPING SCREW
CHAIN ADJUSTING SCREW
RULER

ADJUSTMENTS:

(1) Vertical adjustment: Adjust the ruler, using the chain-adjusting screw, so that the fixed indices at each end indicate the same range.

(2) Horizontal adjustment: Clamp atmosphere pointer to movable bar by turning to "M" and move latter until the pointer is on the normal, then clamp pointer to fixed bar by turning to "S"; repeat operation for other curves. With all four pointers on the normals and clamped to fixed bar, turn knob until movable index indicates the same range on both scales, and lock the system by turning the last pointer to "L." The ruler is now ready for operation.

OPERATION:

(1) Set each marker on its proper curve;

(2) Set (fixed indices of) ruler to actual range of set-forward point, and clamp;

(3) Set movable index on fixed scale to actual range of set-forward point;

(4) Unlock system and clamp atmosphere pointer to movable bar and move the latter, using knob until the pointer is on its proper curve; then clamp pointer to fixed bar;

(5) Repeat operation for other curves, locking the system with the last pointer used. The movable index now indicates, on the movable (*i. e.*, upper) scale, the corrected range;

(6) As the set-forward range changes, the ruler is moved up or down to correspond; the movable index on fixed scale is set to new range; and each pointer in turn locked to the movable bar and the latter then moved until the pointer is brought back to its proper curve, then locked to the fixed bar—the corrected range showing on the movable bar under the index (opposite the actual range).

CAUTION: The operator **must be certain that one pointer, and only one,** is locked to the movable bar when the latter is moved.

TEST FOR MECHANICAL ACCURACY: Solve the problem several times, using the test points on the chart, the corrected range being indicated in brackets; the mean difference from the bracketed range is the error.

TEST OF OPERATOR: The direct method is to use the test points with movable index covered from view. The reverse method is: After a series of corrected ranges have been determined, clamp each pointer in turn to the movable bar and work them back to the normals, using the knob; the difference between the readings of the fixed and movable scales (in excess of the mechanical error) will be the error of the operator.

TO DETERMINE MUZZLE VELOCITY: Set ruler to range of center of impact of splashes. Clamp velocity pointer to movable bar and move to velocity used for trial shots and lock pointer to fixed bar; then set movable index on both fixed and movable range scales to center of impact of splashes; clamp velocity pointer to movable bar and shift the latter until its range scale indicates the range to target; the velocity pointer will then indicate velocity developed.

In record practice, a tide curve equal to the height of tide plus a danger-space correction is used as the tide curve.

PROBLEMS (Using range board test points, 40-foot site): Actual range 5,000; atmosphere 32; muzzle velocity 2,150; tide −10; wind 100; answer, the corrected range for 10-inch gun, 604-pound projectile, would be 5,175 yards. If the range to center of impact of splashes were 5,200 (*i. e.*, +200 yards beyond target), the proper muzzle velocity for record practice would be 2,200 f. s.

RANGE BOARD (GUNS), MODEL 1909.

68. This board can be used in lieu of the Pratt range board.

OPERATION: Set the correction index to the number at the top of the board which corresponds nearest to the required range, then turn the several rollers until the correct reference numbers for atmosphere, wind, tide, velocity, and travel appear at the extreme left end of the rollers.

Turn the range correction roller until the scale corresponding to the range nearest the required range appears through the window in the lower cover.

Set the slides, marked atmosphere, tide, wind, velocity, and travel, to the corresponding percentage corrections that are read through the openings in the correction index.

The corrected range is then obtained by applying the range correction to the actual range (or from the corrected range scale, if one has been applied).

MORTAR RANGE BOARD, MODEL 1914.

69. This can be used in lieu of the elevation board. The slide is set to the range of set-forward point, and the elevation read off for use in the pits, and also for determining the corrected azimuth for the pits.

To test for accuracy, set the range correction factor "A" at the range "A"; the corresponding calculated elevation and time of flight are then indicated by the engraved reference line "A." Proceed similarly for other test settings.

SET-FORWARD RULER.

70. A device by means of which the travel of target during the predicting interval, plus the time of flight, can be found when the travel during one or two observing intervals is known, thus enabling one to plot the set-forward point. Set-forward rulers are constructed for various intervals, and the slide may be graduated either in seconds of time of flight or in ranges, a separate slide being furnished for subcaliber projectiles. The ruler should be checked by comparing results obtained with calculated results.

OPERATION:

(1) Set the arrow to travel called out by plotter; and

(2) Call out travel opposite corrected range or opposite time of flight corresponding to the corrected range; the time of flight to be obtained from a range table.

TELEPHONE.

71. A telephone is an instrument for reproducing the voice through a wire.

THEORY: The act of speaking produces sound waves which fall against the diaphragm of the transmitter, causing it to vibrate; these vibrations induce alternating-current electricity which causes the diaphragms in the receivers to vibrate similarly, thus reproducing the sound.

There are two classes of telephone sets:

(1) Auxiliary sets, consisting of the telephone proper (excluding the transmitter and receiver), such as wall set, plotter's set, battery commander's set, gun set, and portable set;

(2) Talking and hearing sets, such as head set, hand set, desk set.

The transmitter causes alternating-current electricity to be induced in the talking circuit when the diaphragm is vibrated by the voice.

The receiver reproduces the sound by the vibrating of its diaphragm through the action of the alternating current in the hearing circuit.

The magneto (generator) generates alternating current which rings the bells.

The condenser does not allow the passage of direct current, and thus prevents the battery from running down; and also makes the sound more distinct.

The retardation coils do not allow the free passage of alternating current, and thus prevent:

(1) Cross-talk among the 'phones connected to same battery;

(2) Bell-ringing current from short-circuiting through the battery.

The induction coil, consisting of three separate coils wound one over the other (called primary, secondary, tertiary coils), induces an alternating current in the hearing circuit in unison with the alternating current of the talking circuit.

The hook switch, when up, completes the talking and hearing circuits; when down, it breaks these circuits, thus preventing the battery from running down, and also allows the bells to ring.

There are three circuits in a telephone: primary, or talking;

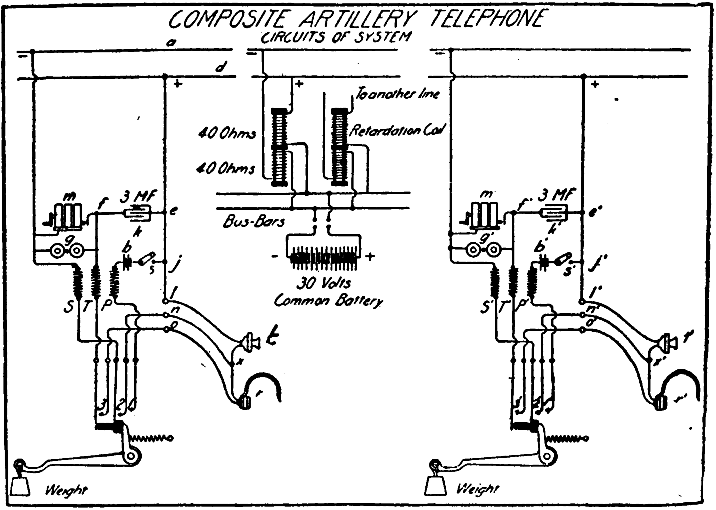
secondary, or hearing; and the ringing. (In the modern metal case 'phones the local battery circuit is omitted, leaving two windings of the induction coil—the primary for talking, and the secondary for hearing.)

The talking circuit is energized with direct current either from a local battery (usually dry cells) in the 'phone, or from a common battery (usually storage cells) in a central plant.

The talking circuit comprises transmitter, primary or secondary winding of the induction coil (depending on whether the dry cells or storage battery is used), battery, retardation coils, and hook switch, all of Home 'phone only.

The hearing circuit comprises the secondary and tertiary windings of induction coils, receivers, transmitters, condensers, and hooks switches, of both 'phones.

The ringing circuit comprises generator, bells, and condenser.



COMPOSITE ARTILLERY TELEPHONE.

S T P (Secondary, Tertiary, Primary)—Windings of Induction Coil. m—Magneto. MF—Condenser. g—Bells. t—Transmitter. r—Receivers. b—Dry Cells.

NOTE.—The student will more readily memorize the circuits if he will trace them in his book in different-colored inks.

Talking circuit: +bat., bus bar, retardation coil, + line,
+ binding post, e, j, l, t, x, n, contact 2, S,
− line, retardation coil, bus bar, − bat.

Hearing circuit:

$$\mathrm{T\;f\;k\;e}\left\{\begin{array}{l} \mathrm{j\;l\;t}\ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \\ +\ \text{line}\ e'\left\{\begin{array}{l} k'\,f'\,T'\,3'\,o'\,r' \\ j'\,l'\,t'\ \ldots\ldots \end{array}\right\} x'\,n'\,2'\,s' - \text{line}\ s\;2\;n \end{array}\right\} \mathrm{x\;r\;o\;3\;T}$$

Ringing circuit: $\mathrm{m,\ f}\left\{\begin{array}{l} g\ \ldots\ldots\ldots\ldots\ldots\ldots\ldots \\ k,\ e,\ +\ \text{line},\ e',\ k',\ f',\ g',\ -\ \text{line} \end{array}\right\}\mathrm{m}$

SELECTION OF OPERATORS: Letters and words of similar sounds should be tried out on a 'phone in good order, and then on one in poor order; operators should speak slowly and distinctly, and those who raise their voices when excited not selected; operators should have a sufficient knowledge of the 'phone to detect minor troubles, such as poor contacts.

USE OF TELEPHONES.

To open station:

(1) Put on head set and see that all connections are tight;

(2) Set switch to proper battery;

(3) Raise and lower hook, which should cause a click;

(4) To signal distant station, hold down hook and turn generator crank briskly;

(5) Call name of distant station, as "**B PRIME**" or "**BC**," etc.

To close station:

Call "**CLOSE STATION**," hang receiver or weight on hook switch, wipe off receiver and transmitter, and turn battery switch to common battery.

Sending messages:

(1) In speaking into a transmitter, hold the mouth one or two inches away and do not let the breath strike the diaphragm;

(2) Speak slowly and distinctly and do not raise the voice;

(3) Send numerals singly, thus 4370 is sent: **four, three, seven, zero**; an azimuth 206.30 is sent: **two, zero, six, point, three, zero**; 200 is sent **two hundred**; 3000 is sent **three thousand**; 6500 is sent **sixty-five hundred**;

(4) If required to repeat, use more distinctness; a figure may be better understood by counting up to it, as **one, two, three,** etc.

(5) Listen to receiver repeat your message, and send again the part misunderstood, and call "**O K**" when correctly repeated.

Receiving messages:

(1) Do not say **HELLO**; when your station is called, reply, "**B**′ (etc.)";

(2) Keep mind on message and receiver close to ear;

(3) Do not interrupt sender unless necessary;

(4) Repeat all messages received; when a part of the message

is misunderstood, call **"REPEAT"** until understood. A long message may be sent and repeated in sections.

TESTS OF THE TELEPHONE.

The "operator's test" consists of the various steps outlined under the "Principal troubles," which are enumerated as follows, the general scheme being to narrow down the field of trouble by disconnecting from the line and observe if this eliminates the trouble:

(1) **No power.** With the switch on "Common" this trouble is indicated by no tap of bell nor click in receiver when hook is raised and lowered, and by receiving no shock upon touching both line terminals with moistened fingers; due to short or open circuit on line—switches may not all be thrown, so observe other 'phones in same station.

(2) **Broken cords and poor hook or tray switch contacts.** These interfering with the circuits cause irregular action. Observe that contacts are not corroded and function properly; manipulate head set and bend cord—if a click is heard, broken cord or contact is indicated.

(3) **Transmitter.** A scratching in transmitter, if heard in receiver, indicates the local talking and hearing circuit in order. Troubles in transmitter are usually due to carbon grains heating and packing when they have been in use an hour or more; to prevent this, telephone service should be interrupted frequently, and the hook switch kept down as much as possible.

(4) **Magneto.** Easy turning of magneto with failure to ring bell indicates either poor contact between shaft and spring, or an interference in the bell striker or armature. If magneto turns hard and bell fails to ring, short circuit on line or in 'phone is indicated; if trouble disappears when line wires are disconnected, the short circuit is in the line.

(5) **Pierced condenser.** This causes poor transmission of speech; magneto turns hard and irregular, failing to ring bell in distant station.

CARE OF THE TELEPHONE.

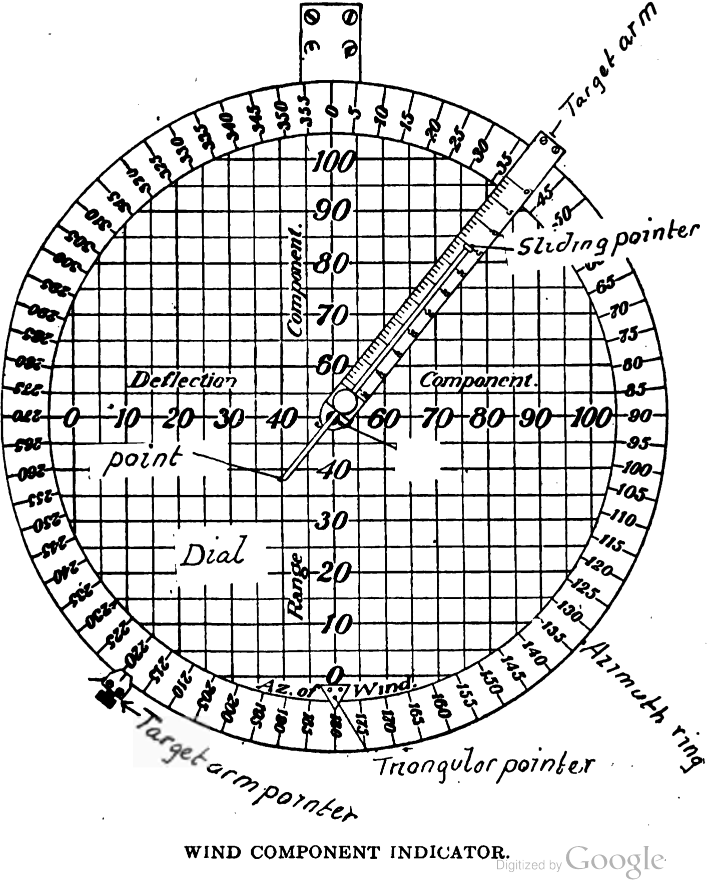
The talking set should be hung up at close of drill, hook springs in place and cords free from twists; nickel work free from rust; transmitter shells not opened by operator; battery switch to "Common"; and report made of unremedied defects.

WIND COMPONENT INDICATOR.

72. A device for determining the wind reference numbers (range and deflection components) to be used respectively on the range and gun deflection boards.

OPERATION:

(1) Set the sliding pointer of the target arm to indicate the wind velocity in miles per hour;



WIND COMPONENT INDICATOR.

(2) Rotate the azimuth ring until the triangular pointer indicates the azimuth of the wind;

(3) Clamp the target arm pointer to the azimuth of target or set-forward point; the point of the target pointer will then indicate, on dial, the wind reference numbers.

PROBLEM (using device): Azimuth of wind, 97; azimuth of target, 280; velocity of wind, 50 M. P. H.; answer, range component, 100, and deflection component, 52.

WIND VANE.

73. A device to indicate the azimuth of the wind, the zero being set to indicate a wind blowing from the south. Chalk marks should be made to indicate the swing of the vane, so that the mean direction can be determined. The azimuth is recorded every twenty minutes, or oftener if necessary.

THERMOMETER.

74. The thermometer registers, in degrees Fahrenheit, the temperature of the air. It should be hung outside, in the shade, away from the heated walls, and exposed to a free circulation of air.

TIDE INDICATOR.

75. A device consisting of a float and pointer to indicate the height of tide, in feet, above low water. The zero (*i. e.*, low water) is located by engineers. The low-water datum plane used on the Pacific is called "mean lower low water," and represents the mean of the lower (of two) tides each day taken for one year; on the Atlantic, both low tides for a year are considered, the term "mean low water" being used.

TIME-INTERVAL SYSTEM.

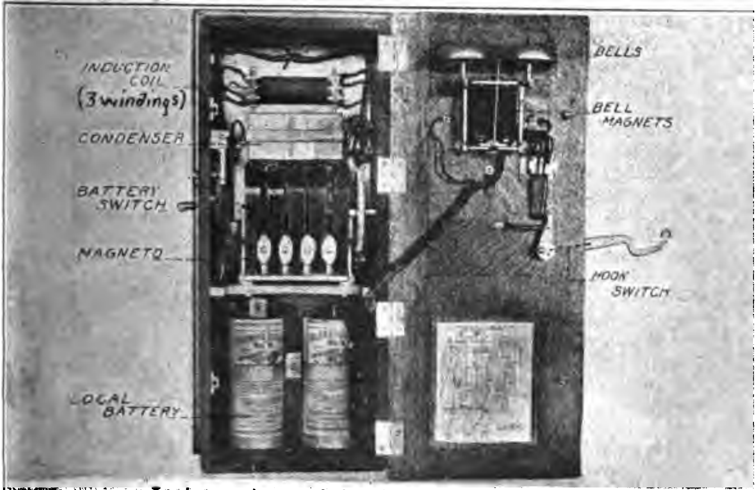
76. Time-interval bells are located in all observing stations and emplacements and are operated by direct current from the switchboard room. The switch panel is set to break the circuits at the intervals desired (usually 28, 29, 30, 58, 59, 60 seconds, and sometimes also 10, 20, 40, 50 seconds). The intervals are established by the time-interval apparatus, which includes a driving motor fed by current from the switchboard. This apparatus is adjusted only by experts and is oiled with clock oil.

TIME-RANGE BOARD.

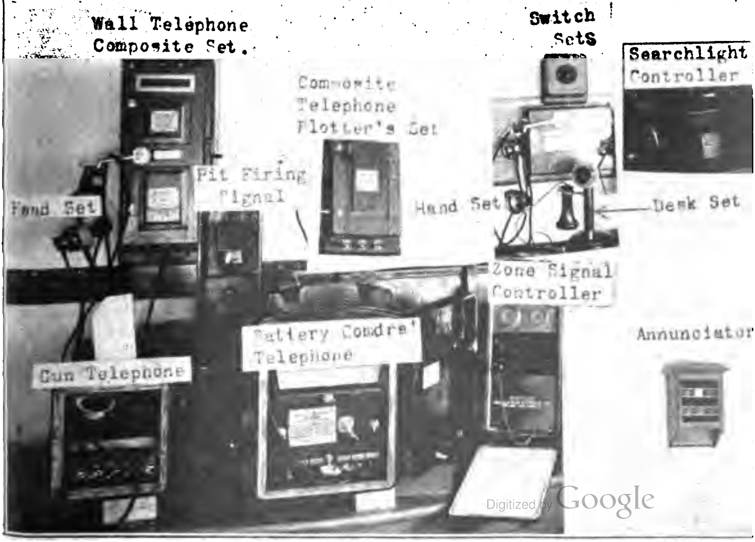
77. On this board, on which is plotted the corrected ranges to set-forward points determined every 30 seconds, is drawn a curve which shows graphically to the personnel at the battery how the target is being plotted.

OPERATION:

The range recorder (member of gun section) plots first range by a cross on first time line on left (top of board if ranges are to



Instruments used in the fortifications



APPARATUS FOR FIRE CONTROL AND DIRECTION decrease, and *vice versa*) and fills out figures on T square; the next range is similarly plotted on next (30 seconds) time line; a full line is then drawn through these points and dotted to next 30 seconds line. This plotting continues (the dotted line being erased after the new range is indicated) across the board and started again on first time line, the necessary changes on the T square being made.

Should a range vary from expected range, as shown by intersection of dotted line with 30 seconds line, as much as 50 yards, it will be indicated by a small circle and not used unless the signal "Target turning" is heard from gun pointer or plotting room. When no such signal is heard, the dotted line will be filled in and dotted to the next 30 seconds line.

The pointer on the T square is made of varying lengths, usually ten or twenty seconds, according to time required to point and fire piece. When the T square is used, the assistant range recorder moves it over the board, passing a heavy time line every 30 seconds (last stroke of bell) and keeping pointer on curve; the gun is laid for the range indicated by the pointer and should be fired (Cases I and II) within a few seconds of the intended firing instant. On boards which have a correction device for gun differences, the assistant keeps the device set according to direction of gun. When the board is used without the T square, the range to be used is taken off curve, the pointing interval ahead, and chalked in figures on the board.

In Case III, in addition to the operations described, the ranges are set down on the proper time line **in figures**, and the gun is fired on the last stroke of the bell.

Whenever a range is taken from the time-range board, a vertical mark is made **on** curve at the pointer; and when the gun is fired, a vertical mark is made at the time and **above** the curve. In plotting a course across the board, the curves should be begun at different points and **not erased**, so that a verification can afterwards be made.

When the command **TRIP** is heard, the range recorder calls out and chalks the proper range; the gun commander observes that the gun goes fully into battery, verifies the range setting, and calls **READY** in time for the gun to be fired at the firing instant. In barbette carriages some other starting instant is selected, and the gun commander does not verify the range.

A **time-range curve** in the plotting room may be substituted for the time-range board. Set-forward ranges allowing for the pointing interval may be sent up every 5 or 10 seconds, chalked on the blackboard, and used in laying the gun.

CHAPTER VI.

DRILLS AND INSPECTIONS.

FORMATIONS FOR DRILL.

78. FORMATION: The first sergeant takes post six paces in front of where the center of the company is to rest, and, facing that point, commands, **FALL IN.** Each chief of section takes post three paces in front of where the center of his section is to rest, and, facing section, superintends its formation.

Each range section consists of B. C., B′ and B″ observing detachments, and a plotting detachment. Each gun section consists of a gun detachment, an ammunition detachment, and a reserve detachment. The gun commander is chief of the gun section and of the gun detachment. Each pit section is composed of four mortar detachments, an ammunition detachment, and a reserve detachment. Gun and mortar detachments are composed of various details, such as breech, rammer, etc. The ammunition detachment is composed of various details for the serving of powder, projectiles, hoist, etc. The reserve detachment is composed of two details, one each for the gun and ammunition detachments.

Each section assembles in two ranks, with 4 inches between files and 40 inches between ranks. Detachments and details form from right to left in the order prescribed for the drill. Chiefs of detachments take post on the right of their respective detachments and are not covered; chiefs of details take post on the right of their respective details and are covered by the lowest odd number of the detail. Mechanics take post on the left of their sections. Musicians form eight paces from the right of the right section (not considering the chief of section).

The first sergeant then commands, **CALL ROLLS.** Each chief of section calls his roll, replaces missing numbers from the reserve detachments, faces about, and, at the command **REPORT,** salutes and reports: "Range section present," "First section present," etc. (or names of unauthorized absentees), and takes post one pace to the right of the front rank of his section.

The first sergeant then commands, **CALL OFF,** and each section calls off in order from right to left, each man calling out his designation, as: Observer B′, reader, gun commander, range setter, No. 1, etc., etc.

He then replaces missing numbers, faces about, salutes, and reports: "—— Company present" (or names of absentees), to the company commander, who has taken post six paces in rear of first sergeant, and then takes post four paces to the right of the right section (not considering chief of section).

When the first sergeant reports, the subalterns take post (range officer on right) six paces in front of the center of the section they supervise at drill, facing the front.

79. INSPECTION IN RANKS: At the command **OPEN RANKS, MARCH,** of the company commander, the rear rank and file-closers move backward four steps, halt, and both ranks execute "right dress." The company commander aligns the front rank from the right of first chief of section, then aligns the rear rank from the right, takes post six paces in front of right chief of section, and, facing down the line, commands, **FRONT.**

Having inspected the company officers, the company commander, accompanied by the officers, inspects both ranks and file-closers; the officers then resume their post, the company commander twelve paces in front of the company, and commands, **CLOSE RANKS, MARCH.**

When the company is to be inspected by another officer, its commander, after opening ranks, from his position on the right front, salutes the inspector and accompanies him. The company may stand at rest until the inspector approaches.

80. TO MARCH THE COMPANY TO THE BATTERY: The command **RIGHT FACE** is given by the company commander; the officer on the right takes post one pace to left of chief of right section, the officer on the left one pace to left of chief of left section; all ranks face to right, the musician in rear takes post on right of other musician; the company commander faces to the left.

The column is marched as prescribed in Infantry Drill Regulations, except that the column extends to easy marching distance, and, in halting, closes up without command. The company commander marches in the most convenient position.

TO POST SECTIONS: When the battery is approached, the battery commander commands, **SECTIONS POSTS**; at this command each chief of section falls out of ranks, conducts his section to its emplacement or station, and commands, **DETAILS POSTS,** at which command all details fall out and procure equipment, and take their posts.

The sections may be posted separately by the command, —— **SECTION, POST.** When the range section leaves the column, the range officer falls out and proceeds to his post.

REPORTS (VERBAL) WHEN MANNING THE VARIOUS COMMANDS FOR DRILL.

81. Gun or pit commanders, after their command, "Examine gun," require their various chiefs of detachments and details, in order, to report condition of matériel ("in order" or defects). He then makes a general inspection of all matériel, especially the recoil and firing devices, and reports to the emplacement officer: "Sir, No. 1 (or 2, or Pit A) in order," or defects which can not be remedied without delay.

Observers inspect their apparatus and report to plotting room, as: "B′ (or B″) in order," or defects.

Plotters require the operators of the plotting room apparatus to report condition of matériel (as: "Range board in order"). They then make a general inspection of station and report to the range officer, as: "Sir, plotting room and communications in order," or defects.

Emplacement officer reports to battery commander: "Sir, Nos. 1 and 2 (or Pit A and B) in order," or defects. Before drill or practice, he inspects all matériel at the emplacements, and tests all firing circuits and safety devices. At close of drill, he reports to the B. C.

Range officer (or in his absence the senior at plotting-room) receives reports of all details and observing stations, and reports to battery commander: "Sir, stations in order" or defects which can not be remedied without delay. Before drill or practice, he inspects all equipment at his station, and verifies all adjustments. On closing station, he reports to the B. C., bringing in such records as may be called for.

Battery commander reports to fire commander, as: "Cranston in order," or defects which can not be remedied.

Fire commander reports to fort commander, as: "Third fire command in order," or defects.

Chiefs of details in fire and fort command stations report to communication officer: "Sir, station in order," or defects.

Communication officer reports to fire commander: "Sir, F′ (or F″) in order," or defects.

Personnel officer reports to fort commander: "Station and communications in order," or defects.

The **matériel officer** receives the reports from the power and light units and reports to the fort commander: "Power and light system in order," or defects.

Tide observer reports to fort commander: "Tide station in order," or defects, and reports height of tide to all fire commanders.

Meteorological observer reports to the fort commander: "Meteorological station in order," or defects, and reports wind and atmosphere data to all fire commanders.

To close drill, the command **CLOSE STATION,** given by the senior in command, is transmitted to all stations and batteries; battery commanders command, **DISMISSED;** range officer commands, **CLOSE STATION;** emplacement officer commands, **REPLACE EQUIPMENTS;** chiefs of sections command, **FORM SECTION.** The company is formed on battery parade as prescribed and marched, by the battery commander, to the company parade and dismissed; subdivisions removed from the battery are marched to the company parade and dismissed by their chiefs.

BATTERY DRILL.

82. Each member of the range section should be individually trained and checked in his duties before team work is attempted; readers should be practiced in reading azimuths, arm setters in setting azimuths, and telephone men in sending and receiving messages. Their work, as regards accuracy, can not be determined except through the recording of all data. In the training of new sections in annual encampments, necessary columns should be ruled as indicated below, and a man assigned to record data used at all drills and target practice. Differences should be entered promptly. The columns of differences indicate at a glance the accuracy of the work; any abrupt or ununiform change results from errors, which should be **immediately** investigated and corrected.

1	2	3	4	5	6	7	8	9	10	11	12	13
Number in Each Course	Range to S. F. Pt.	Dif.	Actual Azimuth to S. F. Pt. (Case III only)	Dif.	Angular Travel (Case II only)	Zone No.	Corrected Range or Elevation to S. F. Pt.	Dif.	Correted Azimuth or Deflection to S. F. Pt.	Dif.	Firing Azimuth to B. C. (Case III only)	Dif.

Azimuths of observed points can be recorded by readers and arm setters, if desired, though this is not necessary. Observed points should plot on a straight line or smooth curve and distances between successive points should be approximately equal. When these conditions do not exist, lines should immediately be drawn through observed points with primary and secondary arms; unequal distances between successive lines drawn from a station will then indicate at a glance errors either by that reader or arm setter.

When moving targets are not available, practice may be had with hypothetical courses. Computed data for such courses are furnished readers who, on the bell, telephone the proper data to plotting-room. To start both readers on the same observation, the battery commander or range officer should announce to all concerned: "Next bell will be No. —."

In loading, the projectile (for guns) is pushed carefully off the truck into the powder chamber, and the truck then withdrawn; the ramming detail man the rammer at the end, and at the command **HOME RAM** of the chief of breech, rush the projectile to its seat, increasing its speed so as to seat it securely. For mortars the projectile is rammed direct from the truck. The powder serving tray (except for B. C.) containing a single charge is then inserted.

and the charge pushed carefully off the tray so that its rear end will be pushed home by the breechblock.

In drilling at the piece it is also necessary to train each man individually, in order to prevent accident and develop team work. Practice in ramming the dummy projectile and sponging is particularly necessary. At disappearing guns, series of three or four shots, by ramming the dummy projectile and tripping only on last shot—the other shots being simulated as closely as possible—is recommended for the development of team work. Similar instruction should be followed at other guns. Mortars may be loaded and unloaded with dummy ammunition each time. In using drill primers, the primer flame-baffle must be attached to obturator, to prevent damage to dummy powder charge.

Disappearing guns that do not counter-recoil to the stops should be embarred "in battery" before they are fired, as otherwise the quadrant angle of elevation might be affected.

COAST ARTILLERY INSPECTION.

83. All armament will be manned and all instruments adjusted, and everything prepared for use. Power plants, lights, and range transmission devices should be in operation. The inspector will visit the stations and emplacements in the order most convenient, and will be accompanied by the immediate commander. As the inspector approaches a station, the personnel will be called to attention by the officer or non-commissioned officer, who will salute.

When the inspector approaches an emplacement, the pit or gun commander will command, **ATTENTION,** and will salute. The gun commander will also command, **OPEN BREECH;** and as the inspector approaches each mortar its chief of detachment will command, **OPEN BREECH.** Such other commands as are necessary to operate the mortar will also be given.

An artillery inspection will be conducted to include:

(*a*) Examination of all equipment, implements, and all parts of guns, carriages and emplacements—special attention being given to: obturators and pads; condition and adjustment of elevating, traversing, and retraction mechanisms; recoil cylinders, and throttling and buffer valves; oil holes and grease cups; adjustment of sight and sight standards and elevation devices; adjustment of subscales of azimuth circles; firing attachment, batteries and circuits, motors and controllers; sponges and rammers, drains and diagrams of same; hoists; light and power installation; galleries; magazines, and grounds in the vicinity. In preparing for inspection, a thin coating of grease will be left on all bearing surfaces. All doors should be opened.

(*b*) Examination of fire control stations and apparatus, special attention being given to the condition and adjustment of all instruments, and to the knowledge observers and operators have of the adjustment and use of all matériel.

(*c*) Simulated target practice at a moving target, with dummy ammunition.

(*d*) An examination of the uniforms worn by the personnel.

(*e*) An examination of emplacement and fort record books.

SALUTES.

84. Salutes are fired under the charge of a commissioned officer; 5-second intervals are employed. After each round, the powder chamber will be sponged and the mushroom head wiped off with a rag dipped in oil.

CHAPTER VII.

SEARCHLIGHTS AND SIGNALING.

85. There are three codes of signals in the service: (1) The American Morse Code is used only on telegraph lines, short cables, and field lines; (2) The International Morse Code is the General Service Code of the Army, and is used for all visual signaling, radio telegraphy, and cables using siphon recorders; (3) The Semaphore Code. The General Service Code is the only dot-and-dash code used in communication between the Army and Navy; the semaphore or any other agreed-upon signals not adapted to dot-and-dash may also be used.

86. Signaling between shore and tug is usually by searchlight with a shutter giving intermittent flashes, or by radio. When these methods are not available, use may be made, during the day, of flags (wigwag or semaphore) or heliograph; and at night Ardois, acetylene lantern, torch, electric light blinker, Very pistol, or rockets—each with its appropriate code.

The following rules will be habitually observed:

(1) A red flag exhibited at the battery or point previously agreed upon, when ready and during firing, and on the tug when the course is clear. At mortar subcaliber practice this battery flag may be dipped as each shot is fired.

(2) In acknowledging signals the tug will repeat signal.

(3) A direction signal (Nos. 2, 3, 4, 8, and 9 of special code) having been acknowledged, the tug will move in that direction until other orders are received.

(4) A signal not acknowledged, or acknowledged incorrectly, will be repeated every ten seconds until acknowledged correctly.

(5) The signal "Range correct" refers to the position of the target; the tug will govern itself accordingly (see Nos. 1, 2, or 6).

The following special code (General Service) will be habitually used when possible:

1. Range correct, ready to fire	K
2. Commence towing	C
3. Go out	O
4. Come in	I
5. Distress	D
6. Hold stationary	S
7. Turn	T
8. Incline to port	L
9. Incline to starboard	R
10. Close practice	Z

EXPLANATION OF SHORE-TUG SIGNALS.

1. **Range correct, ready to fire.**—This signal is supplementary to the firing signal at the battery. At mortar subcaliber practice it may be sent as each shot is fired.

2. **Commerce towing.**—Directs towing on the course prescribed.

3. **Go out**, or 4. **Come in.**—Directs tug to move on line from or towards the battery firing until directed otherwise.

5. **Distress.**—Sent by tug and indicates interference due to fouling or other cause; or, at night, that a shore light is interfering with a patrol boat. Distress whistle signals may also be used by tug. In any case the nature of trouble should be communicated by tug. When trouble is removed, Signal No. 1 should be sent by tug.

6. **Hold stationary.**—Directs the tug to remain stationary until further orders.

7. **Turn.**—Directs the vessel to turn about 180°; or if given after No. 6, 180° from the course followed just prior to that signal.

8. **Incline to port**, or **Incline to starboard.**—Directs the vessel to incline in that direction two points (*i. e.*, 22½°). If given after No. 6, to run a course two points from that followed when No. 6 was given.

9. **Close practice.**—Indicates that firing is over. The tug will carry out orders given previously or by signal.

87. The following is the General Service Code alphabet and numerals; with the wigwag (the signalman facing the station he is communicating with), the motion to the right is a **dot**, to the left a **dash**, and down in front of sender to indicate a pause or conclusion; with the heliograph, or acetylene lantern, or searchlight with shutter, opening the shutter for one second is a **dot**, and for three seconds a **dash**.

Alphabet.						Numerals.	
A	. —	J	. — — —	S	. . .	1	. — — — —
B	— . . .	K	— . —	T	—	2	. . — — —
C	— . — .	L	. — . .	U	. . —	3	. . . — —
D	— . .	M	— —	V	. . . —	4	. . . . —
E	.	N	— .	W	. — —	5	. . . . .
F	. . — .	O	— — —	X	— . . —	6	— . . . .
G	— — .	P	. — — .	Y	— . — —	7	— — . . .
H	. . . .	Q	— — . —	Z	— — . .	8	— — — . .
I	. .	R	. — .			9	— — — — .
						0	— — — — —

When no shutter is available, the beam of the searchlight may be used like the flag; a movement to the right indicating a **dot**, to the left a **dash**, and lowered for **front**.

88. Posts may use International Code Flags for communicating with passing ships.

89. The acetylene lantern consists of a generator for making acetylene, and a lantern proper. The generator is charged with a cartridge (can) of carbide and its reservoir filled with water. The water, coming in contact with the carbide, forms the illuminating gas, the pressure of which automatically stops the flow of water until the pressure falls.

SEARCHLIGHTS.

90. The standard searchlights are 60-inch (diameter), but there are some 24-inch, 30-inch, and 36-inch in the service; the diameter in inches of the mirror determines the size of the light. Searchlights are located so as to cover the water areas and landing places effectually and without interference, also to support each other; high sites are objectionable, because of the unilluminated space under the light when the light is covering the outer field, and because of the interference of high fogs, which frequently leave the water open for navigation. They should be advanced several thousand yards to the front of the outer line of the primary armament to provide illumination for long ranges, but must be protected by rapid fire or movable armament. Under favorable conditions, 60-inch lights will illuminate white vessels about 8,000 yards, and 36-inch, about 5,000 yards; the range of these lights is considerably reduced in foggy weather, or when the vessel is painted differently. Depending on their tactical use, searchlights are classified as searching, or illuminating lights; and, depending upon their assignment, as fort, fire, or mine lights.

The principal parts of a searchlight are: the reflector or mirror, lamp, drum or barrel, glass front door, standards, turn table, pedestal, and training mechanism.

Searchlights are trained by hand, or electrically (by controller). The electric training mechanism consists of two motors with trains of gearing for elevating and traversing, located in the pedestal; these are operated by turning the elevating or traversing handwheels of the controller located in the fort or fire command station. Clutches are provided to throw in and out the electrical control; the beam should be oriented before the traversing clutch is thrown in. Two cables enter a searchlight; the power cable for the arc and the controller cable for the training mechanism; these come from a switchboard on which are mounted the meters and a circuit breaker, which controls the current.

The lamp mechanism consists essentially of two carbon-holders and two magnets: a starting magnet to start the arc, and a feeding magnet to maintain the carbons the proper distance apart.

There are two separate circuits: (1) the series circuit, which contains the arc and the starting magnet, and (2) the shunt circuit, containing the feed magnet. With the carbons slightly apart, when the circuit breaker is closed, current passes through the feed magnet and attracts its armature; the armature thus attracted operates, with a pawl, the ratchet wheel, thereby moving the carbons closer together; this movement of the armature breaks the circuit, and a feed spring draws the armature back; these operations continue, causing a "clicking" noise. When the carbons touch, the large flow of current passing through the starting magnet attracts its armature, which operates to pull the carbons apart, thereby forming the arc of vaporized carbon. The armature feed spring is so adjusted that its force is in equilibrium with that of the attractive force of the feed magnet when normal voltage across the arc exists; as the carbons burn away and the arc lengthens, the voltage across the arc rises, thereby causing more current to flow through the feed magnet and making it feed the carbons closer together; if the arc shortens, the voltage falls and causes less current to flow, which does not exert sufficient attractive force on the magnet to draw the armature against the action of the spring, and this condition exists until the arc increases to the proper length by the carbons burning away.

An important characteristic of efficient service is to maintain a constant voltage across the arc; a rheostat and voltmeter are inserted in the circuit for this purpose and the rheostat kept adjusted so the voltmeter shows the normal pressure across the arc. Carbons which give a good arc, the beam properly focused and controlled, and a careful manipulation of the mechanical parts, are also essentials.

The reflector is a glass mirror and its parabolic form reflects the light rays approximately parallel when the arc of vaporized carbon is at the focus. Focusing is accomplished by bringing the arc on the cross wires of the finder of the peep-hole (if there is a peep-hole), or by observing well off from the side that the rays are parallel. If the rays diverge, the arc is between the focus and mirror; if they cross, it is outside. Moving the arc toward the focus causes the rays to become more nearly parallel and the beam to contract, and *vice versa*.

The carbon farthest from the reflector is the larger of the two, is sometimes cored, and is termed the "positive"; it contains the crater—the most brilliant part of the arc. The other is the "negative." Carbons must be kept dry and adjusted in their holders so their axes are in alignment; a tendency of the crater to form on the edge indicates cross-alignment. Fierce hissing indicates cracking of the carbon, which ruins the crater and necessitates recarbonizing; carbons so damaged should be reshaped in a lathe before being used. Carbons are issued in sealed packages and so kept until ready for use. Carbons much exposed to moist air are improved by warming. In order that the carbons may be kept heated so that the light will be ready for immediate use, an occulting switch, which when open throws an extra resistance in the circuit, cutting down the current, is provided; the carbons are then held together by locking the feed magnet. This switch is closed when the light is in action.

A searchlight is put out of action (*i. e.*, occulted) by simply tripping the circuit breaker; this cuts off the current. If the lamp is to be held ready for immediate use, as at drill, then, (1) open occulting switch, (2) close circuit breaker, (3) feed the carbons together by hand, and (4) lock feeding magnet. Never open the occulting switch while current is on, as sparking may damage the switch clips.

To put the light in action, (1) separate carbons slightly by hand feed, (2) unlock feeding magnet, (3) close occulting switch, (4) close circuit breaker, and (5) adjust rheostat for proper voltage.

To recarbon, trip circuit breaker, separate the carbons by hand feed, and substitute new carbons in the holders, gripping them near the outer ends and being careful to align them.

Care.—An inspection of all parts should be made once each month, and the lamp cleaned and carbon particles removed after each period of operation. The motors and bearing surfaces need frequent oiling. Commutators are smoothed with sand (not emery) paper. The mirror is dusted with a soft brush and then polished with chamois; grease can be removed with a solution of chalk, water, and alcohol—the preparation being first allowed to dry on the surface. The light must never be operated with the arc between the focus and the mirror, as the heat may damage the mirror. The beam should never be elevated above 30°, as hot carbon particles might fall on the mirror and damage it. Moisture must never be allowed in or on the light, and the light should be covered when not in use.

The senior fort commander, through the matériel officer, controls all searchlights, or he may turn over the control of a light to a junior. The matériel officer is stationed in the fort command station, and is responsible for the drill of the searchlight details.

Illuminating lights are intended, primarily, to illuminate targets assigned to fire commands, and, when so used, are controlled by fire commanders; they are put in action only by order of the fort commander. An illuminating light may, however, be used for searching, in two ways: (1) by the fire commander, acting under orders of the fort commander to search a certain area, or (2) by the fort commander direct by telephone.

For the purpose of control, the water area is divided into subareas, each distinguished by a name, which, if practical, will be the same as the subareas of the battle areas; these subareas may be divided into two or more sectors, termed RIGHT, LEFT, MIDDLE. Searchlights of a coast defense command are designated by numbers, as "ONE," "TWO," etc., or by name, and may be permanently assigned to areas.

A searchlight is individually used in searching by moving it slowly back and forth throughout the designated area, and occasionally given an up-and-down motion; when a target is detected, a report will immediately be made to the officer controlling the light, and the light kept on the target until further orders.

The normal collective use of searchlights is as follows: The lights are, by command, put in action and search designated areas; beams, if necessary, kept approximately parallel so as not to interfere. The beams of two of the outer lights may be thrown across the harbor entrance, thus forming a barrier. When a target is picked up, it is reported and followed by that light to the end of the area, then covered by the next adjacent light—the first light uncovering and searching. When the fort commander desires to open fire, he directs the vessel to be covered by another light, which then becomes an illuminating light.

Manning party for a searchlight receiving power from a central plant:

At the fort (fire or mine) commander's station: controller operator.

At the light: operator, assistant, watcher, and telephone operator.

When power is furnished by a local gas engine, an engineer has to be added; when furnished with power from a local steam plant, an engineer and fireman have to be added.

A searchlight operator should be a man of intelligence, interested in his work, appreciating its importance, and possessing experience in electrical and mechanical apparatus. Operators should not be changed from light to light, as they require different handling.

A watcher should be a man of intelligence, with normal vision (20–20) without the use of corrective lenses, and free from color-blindness. He should be instructed in the hydrography of the harbor, methods of identification, and characteristics of vessels. He is equipped with a field glass, wears a head set bridged on the searchlight 'phone, and is stationed slightly in front, below, and on a flank of the light.

SEARCHLIGHT COMMANDS.

91. A searchlight is put in (or out of) action by the command **(TWO) IN ACTION** (or **TWO OUT**). **FOUR, SEARCH** directs searchlight No. 4 to search its entire assigned area; **FOUR, SEARCH BONITA** (or **RIGHT**) directs it to search a particular area or sector of its assigned area. If searchlight No. 4 is covering a target, the command is **FOUR, UNCOVER AND SEARCH**—the word "uncover" apprising the operator that the officer knows that the light is already covering a target. **TWO, COVER THREE** directs searchlight No. 2 to cover target illuminated by searchlight No. 3.

AZIMUTH (275), FOLLOW, FOCUS, SPREAD, CONTRACT, RAISE, LOWER, RIGHT, LEFT, preceded by its number, are commands to accomplish the object indicated. **SLIGHTLY** is added to the command **RIGHT, LEFT, RAISE**, or **LOWER**, when a small motion is desired; otherwise the motion should continue until the command **HALT** is given.

ELEVATE directs the beam to be raised 30 degrees and held there until further orders.

NIGHT DRILL.

92. Battery night drill has for its object the instruction of the battery personnel in the use of the equipment at night. A tug is sent out and illuminated by a searchlight.

Coast defense, fort, or fire command night drill is a searchlight drill, in that it has for its object the instruction of the personnel in the tactical handling of searchlights. One or more boats are sent out before the assembly and, at the appointed time, move according to instructions. All lights, except those required by navigation laws, are extinguished. All fire control personnel, gun pointers, and traversing details attend. The efficiency of the lights may also be tested and improved upon by the commander taking station on one of the boats and directing, by signal, the drill.

Searchlights will be thrown only on vessels provided for drill. When a beam comes on another vessel, it will be immediately removed.

The officer controlling a light should be informed before it is put out of action for any purpose, in order that he may assign its functions to another light.

CHAPTER VIII.

COMMANDS.

Fort Commander:

93. ALL FIRE COMMANDS (or F THREE, or F FOUR, etc.)—TARGET—(sub-area)—(description, see explanation under "Battery Commander")—COMMENCE FIRING, or FIRE COMMANDER'S ACTION, or FIRE WHEN IN RANGE, or FIRE WHEN AT —— YARDS, or FIRE AT ——— INTERVALS, COMMENCE FIRING, or FIRE AT SHIPS IN ORDER IN LINE (or IN COLUMN), COMMENCE FIRING; CEASE FIRING; FIRE ON SALVO POINT No. ———, COMMENCE FIRING; CHANGE TARGET.

Fire Commander:

ALL BATTERIES (or name of any battery or batteries, as CRANSTON)—TARGET—(sub-area)—(description, see explanation under "Battery Commander")—COMMENCE FIRING, or FIRE WHEN IN RANGE, or FIRE WHEN AT ——— YARDS, or FIRE ——— ROUNDS, COMMENCE FIRING, or FIRE AT SHIPS IN ORDER IN LINE (or IN COLUMN), COMMENCE FIRING; CEASE FIRING; CHANGE TARGET; TARGET OUT OF ACTION; CHANGE TARGET, SHIP No. ———; CLOSE STATIONS; BATTERY COMMANDER'S ACTION; FIRE ON SALVO POINT No. ———, FIRE.

Battery Commander:

TARGET—(sub-area)—(shortest necessary description, as STEAMER BARRETT, or STEAMER COMING IN, or BATTLESHIP DIVISION, SHIP No. ———, or CLASS (3-2), or IN 5)—TRACK (or VERTICAL BASE TRACK, or B' AUXILIARY BASE, TRACK, or EMERGENCY SYSTEM, TRACK, or HORIZONTAL BASE, TRACK).

CEASE TRACKING.

CHANGE TARGET—SHIP No. ——— TRACK (or VERTICAL BASE, or B' AUXILIARY BASE, or EMERGENCY SYSTEM, TRACK.)

WITH (state kind of projectile, as DUMMY PROJECTILE, or CAST IRON PROJECTILE, or ARMOR-PIERCING SHOT or SHELL), COMMENCE FIRING.

WITH (kind of projectile) FIRE ——— ROUNDS, COMMENCE FIRING.

WITH (kind of projectile) NUMBER(S) ——— FIRE ——— SHOT(S), COMMENCE FIRING.

WITH (kind of projectile), **LOAD.**
CEASE FIRING.
CALL OFF.
RELAY.
DISMISSED.

Company Commander.

OPEN RANKS, MARCH, FRONT; CLOSE RANKS, MARCH; REST; AT EASE; ROUTE STEP, MARCH; COMPANY ATTENTION; RIGHT (or **LEFT**) **FACE; FORWARD** (or **COLUMN RIGHT,** or **LEFT;** or **COLUMN HALF RIGHT,** or **LEFT**) **MARCH; SECTIONS** (or name of section) **POST.**

Range Officer:

CLOSE STATIONS.

Emplacement Officer:

No. ——— TAKE COVER; RELAY; ——— PIT READY; FIRE; DRAW POWDER CHARGE; REPLACE EQUIPMENTS.

Searchlight Commands:

TWO (number of searchlight) **IN ACTION; ——— OUT; ——— SEARCH; ——— FOLLOW; TWO COVER THREE; TWO UNCOVER AND COVER THREE; TWO AZIMUTH ———** (degrees); **——— FOCUS; ——— SPREAD; ——— CONTRACT; ——— ELEVATE; ——— RAISE** or **LOWER** (**SLIGHTLY,** or **HALT**); **——— RIGHT** or **LEFT** (**SLIGHTLY** or **HALT**).

First Sergeant:

FALL IN; CALL ROLLS; REPORT; CALL OFF.

Chief of Section:

DETAILS POSTS; FORM SECTION.

Gun (or Pit) Commander:

EXAMINE GUN; FORM SECTION; DETAILS POSTS; LOAD; CEASE FIRING; RELAY; FROM BATTERY, HEAVE, HALT; ATTENTION, OPEN BREECH, READY.

Chief of Detachment (Mortars):

No. ——— READY; No. ——— LOAD; No. ——— MISFIRE.

Observers:

READY, TAKE; (B′) **ON TARGET** (or B″, etc.).

Chief of Breech Detail:

IN BATTERY, TRIP; HOME RAM.

Range Setter:

ELEVATE (or **DEPRESS**), **HALT; RANGE SET.**

Gun Pointer:

RIGHT (or **LEFT**), **HALT; NUMBER ONE, FIRE** (or **No. TWO**, etc.); **NUMBER ——— ON TARGET.**

Elevation Setter:

ELEVATE (or **DEPRESS**), **HALT; CLAMP; ELEVATION SET.**

No. 3 (Mortars):

ELEVATE.

No. 9 (Barbette Carriage):

HOIST, HALT; LOWER.

CHAPTER IX.

CORDAGE.

94. A **yarn** is a thread of any fibrous material; two or more tarred yarns loosely twisted together form **spun yarn,** and two strands of spun yarn tightly twisted together form **marlin;** a **strand** is a number of yarns twisted together; three or more of these strands twisted together form **rope.** Rope may also be made of metal or fibrous yarns braided together.

The size of a rope is designated in two ways: (1) by its circumference in inches, or (2) by its diameter in inches; the method used should be specified. The spaces between the strands are the **jaws;** a rope is **long-jawed** or **short-jawed,** depending on whether the strands are loosely or tightly twisted together.

Rope is laid (*i. e.*, twisted) **right-handed, or with the sun,** when the strands, followed away from the observer, rotate clockwise; when laid in the opposite direction, it is **left-handed,** or **against the sun.**

Large rope is termed **hawser; cable** is formed by twisting together, against the sun, three right-handed ropes of three strands each.

Rope should be coiled clockwise, and cable, contra-clockwise; and for ventilation should be stored dry and on skids or pegs.

A **bight** is any part of a rope not an end, as, for instance, a loop.

Worming is filling the jaws to make the surface smooth.

Parceling is wrapping (with the lay, or twist) with strips of canvas to protect the rope.

Serving is worming, then parceling, and then wrapping tightly with small stuff laid against the lay; in serving small rope, worming may be omitted.

Seizing is lashing two ropes together by means of smaller cordage, called **seizing stuff,** such as marlin or spun yarn; **round seizing** is when the stuff is wound around both ropes without passing between them; **rack** or **throat seizing** is when the stuff is passed between the ropes.

Nippering is holding together two ropes by twisting a loop around them, using a spike.

Mousing a hook is placing seizing across the opening to strengthen it or prevent its disengaging.

Frapping is drawing together and holding several ropes of tackle while taking up slack.

Whipping is winding twine around the end of a rope to prevent its unraveling.

Splicing is joining ends of rope together by interweaving the strands. There are three kinds of splices: (1) **eye splice,** in which a loop or eye is formed at the end of a rope; (2) **short splice,** to connect ropes not intended to run through blocks, as the size is increased at the splice; (3) **long splice,** to connect ropes without increasing their size, so they can be run through blocks. In the long splice part is cut away and the splice is weaker than the rest of the rope.

A **strap** or **sling** is formed by joining together the ends of a rope; a **grommet** is a ring of rope formed by splicing together the ends.

95. The following are generally used in the service:

Square knot—for joining the ends of rope of the same approximate size.

A **thief,** or **granny, knot** results from tying a square knot incorrectly, and has no merit or use.

Bowline—for forming a temporary eye at the end of the rope; when tied so that the eye encircles part of the same rope, it is called a **running bowline.**

Bowline on a bight—a bowline, or eye, in the middle of a rope.

Anchor knot, or **fisherman's bend**—for tying rope to an anchor.

Carrick bend—for joining ends of large rope or cable.

Clove hitch—for fastening a small boat to a pile, or a heaving line to a cable or hawser.

Blackwall hitch and **midshipman's hitch**—for fastening rope to a hook when there is a steady pull on it.

Cat's-paw is a more secure fastening to a hook than the Blackwall, and is employed when the pull is not steady.

Sheep-shank—for temporarily shortening a rope without cutting it.

Rolling hitch, timber hitch, stopper, and **mooring knot**—for tying rope to a spar or to another rope.

96. Standing rigging comprises stationary ropes, such as guys; **running rigging** comprises ropes running through blocks.

A **block** consists of one or more grooved pulleys or sheaves mounted in a housing; wooden blocks are **made** or **mortised**—depending on whether of one or of several pieces of wood. They are **single, double,** or **treble,** according to the number of pulleys. When the block has a slot in the side so that the bight of a rope can be inserted, it is called a **snatch block.**

A **tackle** is a combination of ropes and blocks working together to aid in moving heavy weights. The block attached to the object to be moved is the **running block,** and the one fixed to the holdfast is the **standing block.** That part of the rope running from the block to which it is attached to the first pulley passed over is the **standing part,** the rope between the blocks is the **running part,** and the rope to which the pull is applied is the **fall.** To **overhaul** a tackle is to separate its blocks; to **round in** a tackle is to bring the blocks together.

The simple tackles ordinarily used are as follows:

Whip, made by a rope rove through a single block.

Whip upon whip—block of one whip is attached to the fall of another.

Gun tackle—two single blocks, the standing end of the rope being fastened to the standing block.

Luff tackle—when single and double blocks are used.

Gin tackle—when double and treble blocks are used.

By **power** of a tackle is meant the weight lifted, divided by the pull on the fall. It is (approximately) equal to the number of parts of the rope attached to or running from either side of the movable block, as, for instance: whip 1 (2 when block is movable); gun tackle 2; luff tackle 3.

97. A **crane, or derrick,** consists of an inclined spar with tackle, resting on the ground, supported by and operated with guys, and used for lifting and transferring weights; when two spars are used, the additional one is vertical and is called the "mast," and the inclined one a "boom."

A gin is a tripod consisting of two legs, a pry pole, the tackle, and sometimes a windlass, and is used for lifting weights vertically. In assembling a gin, the three poles are laid on the ground, heads together, at the proper angle for the bolt and clevis (parallel when a lashing is used), and the pry pole in the middle and pointing in the opposite direction. They are fastened together with bolt or lashing, and the whole erected by lifting the head and bringing up the foot of the pry pole towards the feet of the other two legs.

Shears consist of two spars lashed together, a tackle, and the necessary guys, and are used for lifting and transferring weights at an angle. The two spars are laid on the ground parallel, lashed together, and the whole erected with the aid of guys or other tackle.

98. Hydraulic jacks are used for lifting heavy weights. There are two kinds of jacks of varying capacities, from 15 to 60 tons, viz.: (1) horizontal jack, which may be used in any position, and (2) base jack, in which the head must be higher than the base.

The liquid used in jacks is a mixture of grain alcohol (to prevent freezing) and water, in approximately equal parts, and a spoonful of sperm oil to keep the leather packing pliable. Jacks are filled while the ram is down, either through the screw hole of the lowering valve or by removing the hexagonal cap. To empty, run up ram until it can be pulled out, placing finger over escape hole in the cylinder side, and invert jack so liquid can run out.

Jacks are designed to raise weights of their rated capacity when approximately 150 pounds is applied at the end of the handle. According to the principle of physics, "pressure on a liquid is transmitted equally, per unit of area, in all directions"; *i. e.*, the pressure under the ram per square inch is the same as in the pump pre square inch; the ram, being larger in area than the pump, therefore lifts a heavier weight in proportion to the two areas as liquid is pumped under it. This gain in power is further increased (proportionally) by the leverage of the handle being greater than that of the pump. In using, the jack is placed under the weight, the lowering valve closed, and the handle is operated until the jack is up the required height; a block is placed under the weight, and, with the handle down, the whole is lowered by opening the lowering valve. When the jack can not be placed under the weight, a claw is used.

CHAPTER X.

WARSHIPS.

99. The "Dreadnought" (British) was the first battleship to carry all big guns (12-inch), supplemented by a rapid-fire battery (3-inch) for torpedo attack. In dispensing with the intermediate armament, 6 to 9-inch, carried by battleships prior to this time, the "Dreadnought" was enabled to carry a greater number of large guns. Battleships antedating the "Dreadnought" are termed "pre-Dreadnought." Battleships constructed since are generally of the "Dreadnought" type (all big guns, with rapid-fire guns). The larger ones, carrying larger guns, 14- to 15-inch, are termed "super-Dreadnought."

The battle cruiser is essentially a battleship, but with the higher speed necessary for advance skirmishing and for pursuit. To attain this speed, it was necessary, in order to install heavier engines and boilers, to sacrifice, to a small extent, armament and armor protection.

The armored cruiser has high freeboard, lighter armament and armor than battleships, but greater speed than battleships of the same period.

Cruisers have high freeboard in contra-distinction to battleships, are intended for patrol purposes, and carry light guns and in some cases light armor. The faster cruisers are termed "scouts" and are used to accompany or precede the fleet on scouting duty. Those having protective decks and no side armor are termed "protected cruisers." The small ones used in shallow waters are termed "gun boats," and have low speed and no armor.

Battleships can be distinguished from armored and light cruisers by their more massive appearance, particularly in the superstructure of turrets, guns, and cranes, by their lower freeboard and broader beam, and by their more irregular silhouette. Dreadnoughts can be distinguished from the older battleships by their size, but can not be distinguished from the larger battle cruisers.

Monitors were intended for the first line of battle. Their chief characteristics were the revolving turrets mounted on a heavily armored hull of extremely low freeboard. The type is now obsolete and would be used for coast defense only, though recently monitors have been built and used in rivers and on the coast against the mobile army fortifications and forces.

Torpedo boats were designed for torpedo attack on larger vessels, and possessed great speed, a few small guns, and no armor. They are now used for coast defense purposes, being displaced on the seas by destroyers. Destroyers were designed, originally, to operate against torpedo boats, and possess greater speed than the

GENERAL DISTINGUISHING FEATURES OR CHARACTERISTICS OF WARSHIPS.

(Figures are only approximate.)

Classification.		Tonnage.	Length, feet.	Width (bam), feet.	Draught, feet.	Speed, knots.	Armament, guns.*	Armor.
1) **Armored ships, including:**								
Battleships	Dreadnoughts...	16,000 to 28,000	500 to 700	85	30	20 to 25	8 or 10 12″ to 16″, and 12 to 20 3″ to 6″	11″ to 13″
	Pre-dreadnoughts	10,000 to 16,000	400 to 500	75	26	18	4 12″, 4 8″ or 9″, about 12 3″ to 6″	11″ to 13″
Battle cruisers..............		17,000 to 27,000	550 to 725	85	30	25 to 28	Same as Dread- naughts.	7″ to 10″
Armored cruisers..........		9,000 to 15,000	500	75	28	22 to 25	4 8″ to 10″, 12 to 24 3″ to 5″	4″ to 8″
Monitors.................		3,000 to 8,000	250	50	12	13	2 or 4 10″ or 12″ and 4 3″ to 4″	6″ to 8″

(2) Unarmored ships:							
Protected cruisers	4,000	300 to 400	50	18	20	12 3″ to 6″	2″ to 4″ deck
Scout cruisers	5,000	400	55	25	25 to 30	12 3″ to 6″	May have 2″ or 3″ sid armo & dec
Gun-boats	1,000 or less	250	35	10	12	6 3″ to 5″	None
Destroyers	1,000	275	25	10	30 to 35	5 4″ or smaller	None
Torpedo-boats	300	175	18	6	20 to 25	2 6-pdrs. or smaller	None
Submarines	300 to 2,000	150 to 200	12 to 20	12 to 20	8 to 20	5″ or smaller	None
(3) Auxiliaries, such as colliers, mine-layers, etc.							

*All modern warships carry torpedo tubes approximately 21 inches in diameter.

latter, but are now used with the fleet for torpedo attack and for defense against submarines.

Submarines are designed for under-water torpedo attack, but may have light guns for service above water; they may also be used against fortifications, as on raids against searchlights, observing stations, and mine fields. They may also be used in cost defense work on patrolling duty, particularly in fogs, and against the hostile fleet.

Guns afloat are at a disadvantage when compared with guns ashore, on account of their unstable platform and difficulties of range finding, and because of the more obscure target offered for their gun pointing and spotting. This disadvantage can, however, be reduced by their bringing to bear a larger number of guns, and by the use of aircraft for observation of fire.

CHAPTER XI.

TARGET PRACTICE.

SUBCALIBER PRACTICE

100. The object of subcaliber firing is to practice the gun-pointers and other members of the sections in their duties, and to exercise the fire control personnel in their work Subcaliber practice may be (1) fort command, (2) fire command, or (3) battery—the coast defense commander allotting a portion of the allowance to fort and fire command practice. Battery subcaliber practice and drill will also be had under emergency conditions; under these conditions, one or more elements of the fire control system (for guns, B′, B″, B. C., B′ and B″, B″ and B. C., sight standard and gun pointer; and for mortars B′, B″, B. C., B′ and B. C., B″ and B. C.) will be eliminated. Use will be made of any instrument in any station not eliminated for range and azimuth, but communication will not be had with any station eliminated. Service practice should be simulated; a disappearing carriage will not be traversed while the ammunition is being inserted; the command **READY** will be given at the expiration of the time necessary for the gun to go into battery, and the gun pointer will endeavor to get on target in the time necessary to close breech, plus tripping interval. Trial shots may be fired at moving target; the battery commander starts with normal muzzle velocity, using actual meteorological data, otherwise assumed data, and from his observations of the splash determines a velocity and deflection correction (as explained in Chapters II and V) which will throw the splash just in front of target. In order to prevent loss, a responsible man should be placed in charge of this ammunition during and between firings.

In preparing the service practice equipment for subcaliber practice, changes in the plotting room apparatus are necessary as follows: (1) For guns: chart on range board; T square and drift scale on deflection board; slide on set-forward ruler if graduated in ranges; drawing in and applying scale to gun arm or changing scale of plotting board (par. 52). (2) For mortars: drift scale on deflection board; zone slide on plotting board, and changing scale of board if desired. On disappearing carriages a subcaliber platform is attached to the breech for subcaliber practice, and a weight to balance it attached to the muzzle.

101. To ASSEMBLE SUBCALIBER TUBE IN GUN OR MORTAR: Clean chamber and centering slope; remove dummy plugs from mushroom head and put on spindle plate with its two screws. Insert tray to protect threads of breech recess and insert tube with adapters, using handspike, pushing it smartly forward until the front adapter seats firmly in slope of chamber. Remove handspike and tighten wedge screws; insert locating gauge in bore of tube, leaving flange slightly to rear of face of tube.* Close breech gently; if resistance is encountered, the tube is too far to the rear; open breech and turn the tube right-handed. If no resistance is encountered, open breech and note whether flange of gauge is flush with face of tube; if not, turn tube left-handed. Continue operations until the flange of gauge is flush with face of tube and tighten clamp screw. Close breech on a round of subcaliber ammunition to verify the adjustment.

To dismount tube, loosen both screws, insert handspike and, using tray, lift it out of gun. If the tube sticks, use gun extractor.

102. Immediately on being fired, empty cartridge cases should be dropped into water, decapped, cleaned inside and out, and then dried. Drill primer bodies should be similarly treated.

SERVICE PRACTICE.

INSPECTION.

103. Before service practice the battery commander will satisfy himself that all matériel is ready for service, special attention being paid to the following: adjustment of all fire control apparatus (including D. P. F., azimuth instruments, powder chart, plotting-board, deflection board, range board, set-forward ruler and prediction device, wind component indicator and atmosphere slide rule, as explained in Chapter V); azimuth indices, sights and sight standards, range and elevation scales and quadrants, obturating devices (gas check pad and primer seat), elevating friction device, safety and firing devices (electric and lanyard), throttling and buffer valves, ammunition, shot trucks, elevating and traversing mechanisms, recoil and counter-recoil system; in mortar batteries, a device for checking azimuths and other data must be provided. Breech-blocks will be dismantled, cleaned and oiled.

Immediately after practice, all matériel will be inspected by the battery commander, and a report on its condition made through channels to the coast defense commander. Bores will be washed clean with water, dried and oiled; breechblocks will be dismantled, cleaned and oiled; carriages and emplacements cleaned and cared for.

ADJUSTMENT OF MATERIEL.

104. Ammunition: The powder to be used should be stored in the battery magazine for at least two weeks prior to practice, and the temperature of the powder then considered the same as that of the magazine. The powder must be blended just prior to use (paragraph 20).

***NOTE.—In some tubes a locating gauge is slipped over the spindle plate, leaving space between gauge and plate; the tube is properly adjusted if the gauge is pushed against the plate when the breech is closed.**

All projectiles will be cleaned and their bourrelets freed from paint. Care will be taken that projectiles are seated securely and uniformly, as the improper and non-uniform seating of projectiles results in variations in muzzle velocity.

Shot trucks will be adjusted for correct height, and only those belonging to the battery used.

All grease must be removed from the bore, as its presence would lower the muzzle velocity of the first shot.

The ammunition allowance for National Guard coast artillery is prescribed by the War Department in letters of instruction issued prior to their encampment.

105. Service practices for regular troops are divided into: (1) first practice, and (2) additional practices. The ammunition prescribed for additional practices is used under regulations prescribed by the District Commander. The ammunition allowance per battery "in service" for the year 1917 is as follows:

	First Practice.		Additional Practices.	Total.	Sub-caliber, Rounds.
	Trial.	Record.			
5 and 6-inch guns.	3	8	20	31	900
8 to 14-inch guns.	3	7	7	17	600
Mortars.........	6	12	18	36	150

106. Two pressure gauges will be used for each trial shot. In order to avoid delay, a sufficient number of coppers should be measured beforehand and placed in the available gauges; the coppers need not be removed from the gauges, nor measured, until the last trial shot has been fired. Two pressure gauges are also used for the record practice—one copper cylinder being placed in each gauge before the first shot of the series and not removed until the last shot has been fired, the pressures recorded representing that of the round which had the maximum pressure, but, if practicable, the gauges should be tightened after each shot. When firing trial and record shots at moving targets, the same gauges and coppers may be used without changing.

107. The sight standard, azimuth indices, range scale, and quadrant must be in adjustment. (See paragraphs 32 and 33.)

108. Obturating and safety firing devices: The breech mechanism should be dismantled, cleaned and oiled, and the gas check pad adjusted (paragraphs 26 and 27); if the pad is soft or the canvas torn, another should be substituted. The primer seat, vent, and firing mechanism should be cleaned. A combination primer should not discharge by a sharp, quick pull on the firing leaf until the breechblock is completely rotated. The continuity of the electric circuits of primers to be used should be tested; the circuits of the gun and carriage should be tested with an electric primer, which should not fire until all switches and contacts are closed.

In disappearing carriages, the safety lanyard device should not operate to permit the lanyard being withdrawn until the top carriage is about 12 inches from the stop; for mortars, the ring should not release until the muzzle is pointed above the parapet.

109. The **elevation friction device** will be adjusted as explained in paragraph 34, and the elevating and traversing mechanisms cleaned and oiled.

110. The **recoil system** must be cleaned, the cylinders filled, the throttling and buffer valves set (paragraph 38), and stuffing boxes adjusted (paragraph 39). Old grease should be removed from all sliding parts and new grease applied, and grease cups adjusted (paragraph 37).

FIRING OF TRIAL SHOTS.

111. The muzzle velocity of the powder to be used can be determined in one of two ways: (1) by a consideration of the previous firings of the same lot of powder, noting the velocities used and correcting for the overs and shorts; or (2) by the firing of trial shots. The object of trial shots is to determine for the firings which follow: (1) for guns, the muzzle velocity of the powder and the arbitrary deflection correction; and (2) for mortars, the range and arbitrary deflection corrections (where the mortar elevation board is used, the muzzle velocity is determined), and to secure data for a study of velocity, atmosphere, and wind effects.

All trial shots are fired from the same gun or pit, the piece being laid with the same elevation and azimuth on a point at mid-range, the various corrections being made on the deflection board (also range board for guns); the muzzle velocity assumed is based on previous firings of the powder, the records of which are usually obtainable from the ordnance officer, War Department general orders, or C. A. memoranda. Powder fired at a higher temperature gives a higher muzzle velocity, and *vice versa;* consequently, if the temperature for record shots differs from the trial shots, or if there is a variation in powder temperature of several series, an allowance, as determined by the powder chart or rule, should be made. Trial shots may also be fired at set-forward points of a moving target and splashes similarly located.

The splashes are observed at all stations of the fire command, and, with the point fired at, will be plotted on all plotting boards with the aid of the F. C. plotting board pantograph. Observers set their instruments at the azimuth of the point fired at, and should be informed a few minutes before each trial shot is fired; splashes are bisected with the vertical wire and the reading of instrument personally verified by observer before sending to plotting room. The difference in range to the center of impact of splashes and the point fired at gives, for mortars, the range correction; and, for guns, the basis on which the muzzle velocity can be determined.

112. The deflection correction is the difference in azimuth of the point fired at and the center of impact, using correction reference number less than 3.00 when the splashes fall to the right, and *vice versa*. The deflection correction for guns can be better determined, however, by keeping the gun at the azimuth fired at and bisecting the splash with the movable wire; the difference between the splash reading and the deflection determined from the deflection board being the arbitrary correction to be used. When a material target is used, the correction can be determined, both for guns and mortars by using a telescopic sight or azimuth instrument; the sight set at 3.00 is kept on target, and when the splash occurs the movable wire is run to the splash; the angular deviation is converted into yards at target by multiplying its tangent by the range to target, the latter being measured on plotting board; the conversion into yards can be quickly approximated by the use of mils, one mil (.05° approximately) in yards at any range being equal to that range divided by 1000. With azimuth instruments not provided with deflection scales, the angular deviation is the difference in azimuth of target and splash.

113. A range correction is made as follows:

(1) For mortars, by (*a*) sliding the zone slide out for overs and in for shorts the correction desired, or (*b*) constructing a new paper scale for each zone, based on the muzzle velocity determined from the trial shots and pasted on mortar arm (or from the zone chart when the mortar elevation board is used, by setting the ruler to the muzzle velocity determined). See paragraph 14.

(2) For guns, by determining a new velocity as described in paragraphs 67, 49, and 14.

PLOTTING SPLASHES AND DETERMINING THE FIGURE OF MERIT.

114. A line is drawn through the mean of the plotted (observed) points to represent the course of the target. The position of the target on this course for each shot is determined by the intersection of the gun arm, primary or secondary arms, set at the azimuths of the target which were read from the azimuth instruments mounted at the battery, primary or secondary stations, at the instant of splash. Before the plot is moved, the range officer will draw lines of direction with gun arm through each position of the target at instant of splash, and locate two datum points thereon, so that the plot at any time thereafter can be oriented.

115. Targets: The record target for guns 8-inch and above (also 5-inch and 6-inch in first practice) is a silhouette as shown on Forms 1000 and 1000A, having the center of its water-line at the center of the water line of the towed target (as seen from the battery), and its water line on the course of the towed target. The record target for mortars is the plan of a battleship shown on Form 1001, having its center on the center of the towed target, and its longer axis on the course of the target. Using cross-section paper 50 yards to the inch, locate towed target at intersection of two heavy lines (T) and lay off on heavy line (U) the position of observer on tug (tow-line measurement from Form 823). Draw a line of direction through target (T), making angle B, with course of target (angle determined with protractor from plotting board).

For rapid-fire guns (also 5-inch and 6-inch, except in first practice), the towed target is a material target 10 feet high by 24 feet long; all shots, direct or ricochet, striking the canvas, masts, or raft between the masts, are counted as hits.

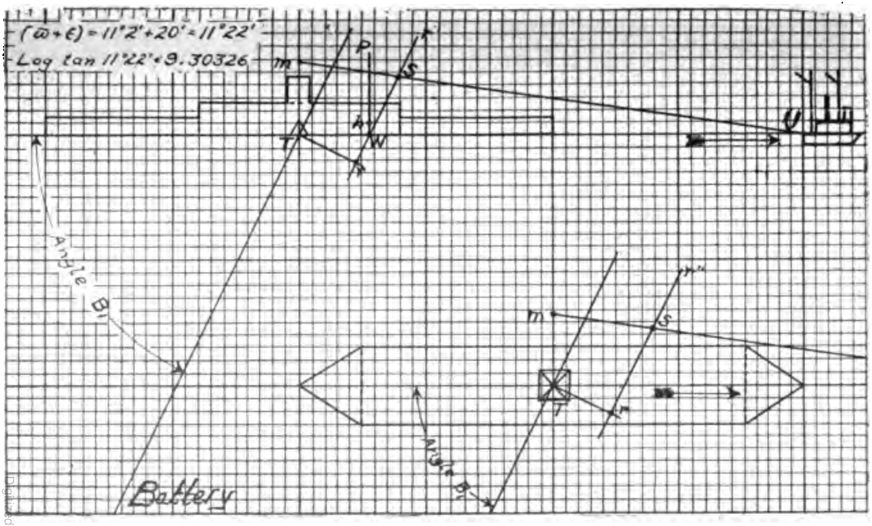
116. The position of the splashes with reference to the towed target is determined from observations made on shore and tug, as explained under Forms 822 or 823, paragraph 123.

117. Hits: Lay off $T\,m$ on line through target perpendicular to track equal to the deviation of splash in yards, and $T\,U$ equal to length of tow line (taken from Form 823; camera record if reliable); the splash lies on line through $U\,m$. Lay off $T\,r$ on line through target perpendicular to line of direction equal to lateral deviation of splash in yards (taken from Form 822); draw line $r\,r''$ parallel to line of direction; the splash lies on this line. The intersection of the two lines containing the splash determines its location. For a gun battery, lay off to same scale the proper silhouette shown on forms. Shots which pierce the silhouette or fall not more than 10 yards short of the water line, measured parallel to line of direction, are hits, with values as shown on forms. To determine whether a shot pierced the silhouette, multiply the distance in yards from the point of splash (S) to the water line (W) of the target (measured on line parallel to line of direction) by the tangent of the angle of fall corrected for height of site and curvature. This corrected angle of fall $= (\omega + \varepsilon)$; ω (omega) being the angle of fall taken from range table corresponding to range drum setting, and

$$\tan \varepsilon = \frac{\text{height above water} + \text{curvature of earth}}{\text{actual range to target} + \text{long. deviation } (r\,S)}$$

$$\text{The curvature of the earth (in feet)} = .2154\left(\frac{\text{Range in yards}}{1000}\right)^2.$$

The result will be the approximate height in yards that the shot passed above the water line of the silhouette; plot this distance on a perpendicular ($W\,P$) to the course of the target at the intersection of the line of splash; if it comes within the silhouette, it is a hit, with value as indicated on the forms. The value of the



T = Center of material target.
U = Position of range observers on tug.
Tm = Deviation in yards with reference to line joining tug and target (Form 823).
B_1 = Angle between course of target and line of direction = 63° 40′ (see p. 107).
Tr = Lateral deviation in yards (Form 822) = 25 yards.
S = Splash.
Sr = Longitudinal deviation = ×38 yards (to be entered on Form 819).
WS = Actual number of yards shot passed beyond target = 26.6 yards.
WP = Intersection of vertical plane of trajectory and vertical plane of target.
Wh = Approximate height that the shot passed above water line of target, = WS tan $(\omega + \epsilon)$ = 5.3 yards.
h = Point of perforation of silhouette target.

CROSS SECTION PLOT.

corrected angle of fall and tangent used in each case will be entered on the cross-section paper. A separate plotting will be made for each shot; where shots are obviously misses, the silhouette need not be plotted.

For a mortar battery, lay off to same scale the battleship plan, with dimensions as prescribed on Form 1001; splashes which plot within the target only (not ricochets) are hits, with values as shown on form.

118. The figure of merit is for the purpose of comparing the work done by companies in service practice.

$$\text{For guns,}\quad M = \frac{C\,H}{P \sin B + \frac{g\,t}{100}} + \frac{500}{E}$$

$$\text{For mortars,}\quad M = \frac{C\,H}{P \sin B + \frac{t}{100}} + \frac{500}{E}$$

in which—

M = the figure of merit;

C = Constant for particular caliber, as follows: C = 2.8 for all guns 5 inches and larger; and 1.0 (unity) for mortars and guns less than 5 inches;

H = number of hits;

P = probability of hitting (see table of Annual Instruction Order);

g = number of guns used;

B = mean angle, in degrees, of track of target with line of direction (the line from directing point is used); the minimum value allowed for sin B is .643;

E = mean longitudinal error, in yards, of series (see Chapter II);

NOTE.—In the plotting, as described, it is assumed that the lateral deviations were taken from the battery, in which case the line of observation (*i. e.*, drawn from observer determining lateral deviations, to target) is the line of direction. When the lateral deviations are, however, taken from the primary, lines of observation should, in addition, be drawn on plot, and their angles with the course measured and recorded. Both sets of lines (observation and direction) are necessary on the cross-section plot for the following reasons: the lateral deviation *T r* is laid off perpendicular to line of observation and *r r'* is drawn parallel thereto; the longitudinal deviation for Form 819, however, is always measured from splash perpendicular to a line through target, perpendicular to line of direction; and the lateral deviation is measured from splash perpendicular to line of direction.

t = corrected time of series in minutes to third decimal place. The total time is from command of battery commander "Commence firing" to discharge of last shot; time out is allowed for (1) interference of vessels, (2) delays incident to the movements of the towing tug, (3) defects in matériel which could not, in the opinion of the umpire, have been foreseen and remedied by the battery commander, (4) whenever the firing of a mortar battery is suspended on account of excessive lateral deviation, (5) obscuration of target.

In computing the figure of merit, all fractions will be expressed to the third decimal place; in discarding a fraction, the figure in the third decimal place will be increased one in case the figure in the fourth decimal place is 5 or greater. The maximum value allowed for the second term $\left(\frac{500}{E}\right)$ is 10. When the number of shots differs from the number prescribed in the first practice for regular companies, multiply the first term (H) of the figure of merit by $\frac{n}{n'}$, in which n = the number of shots prescribed, and n' = the actual number fired; National Gaurd companies use a different factor. as may be directed by the War Department.

SAFETY PRECAUTIONS.

119. The coast defense commander prescribes the course of the target, and will not permit the practice until, through personal inspection, he is satisfied the personnel is properly instructed and the practice can be held with safety.

The fort commander conducts the practice from his station, and is responsible for the safety of the range; he is assisted by a safety officer, appointed by him.

The fire commander supervises all preparations for the practice and conducts the practice from his station.

The battery commander is responsible that all of his battery personnel understand the safety precautions which follow, and will personally question them on these points.

1. Before the firing, all men at the battery will be cautioned to place protectors, waste, or cotton in their ears. They will not close their ears with their fingers.

2. A service primer, inserted with breech translated but not rotated, should not fire at any part of the rotation by a quick, hard pull on the lanyard until the breech is fully rotated. The primer must not fire electrically until all contacts and switches are closed. The primer will not be inserted until the breech has been

the primer is inserted, but for mortars, it is not hooked until th mortar has been elevated 45°.

3. After each round is fired, the breechblock and recess wi be wiped out with a cloth saturated with oil, and the chambe sponged with a sponge saturated with liquid for sponging.

4. Only one powder charge will be allowed on the platfor or mortar pit at any one time; No. 6 (mortars) must not approac the piece until the sponging has been completed.

5. In case of misfire, the primer will not be removed for least ten minutes, and then with a hook; during this interval, th piece will be pointed where its discharge would not endanger shi ping or the personnel. In firing by electricity, the circuit is broke before primer is removed.

6. If the fall of any projectile is such as to imperil the safet of any boats, the safety officer will command **CEASE FIRIN** and the cause will be investigated.

7. Whenever a junior is ordered to fire under circumstances h judges unsafe, he will hold the fire until report can be made t the next higher commander.

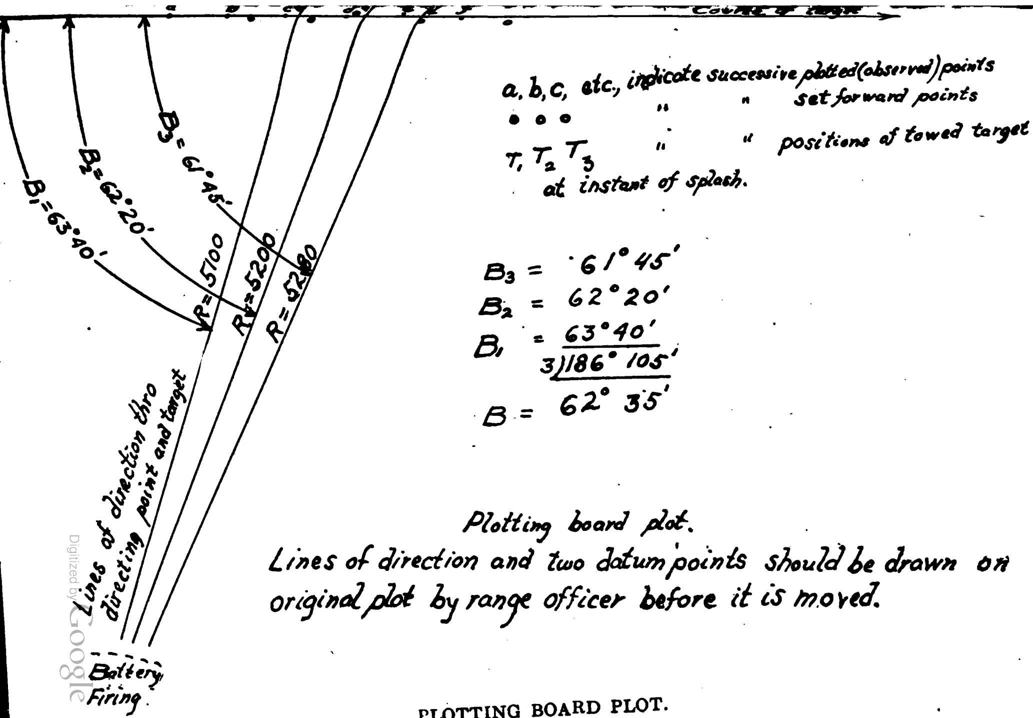
8. During the firing, a red flag will be displayed only at th battery firing or at a point previously agreed upon; also on th towing vessel when the course is clear. No firing will occur whe either flag is down.

9. At the command **CEASE FIRING**, lanyards will be detached, and electric circuits, when being used, will be broken.

10. Night practice: (*a*) The date of the practice will be published so as to reach, without fail, shipping and fishing interest (*b*) The day and hour will be selected with a view to having th practice at an hour when there is least likelihood of a vessel crossi the range. (*c*) The field of fire will be patrolled before dark wit a view to determine whether or not vessels are anchored therei and also to warn approaching vessels. (*d*) Signal vessels will located so as to observe any vessel approaching the range durin firing, and to signal the battery firing by rocket or other mean (*e*) An officer will assure himself that the gun is pointed at th target for the first shot of any series.

DUTIES OF UMPIRE; PENALTIES.

120. An umpire is detailed by the district commander to b present during the firing of trial shots and first practice. He ha charge of all time-keeping and the determination of lateral deviations, overs, and shorts. He represents the district commande and will inform the coast defense commander if the regulatio are not being carried out. His decision in all matters arising final, but a written objection can be made later to the War Department by the coast defense commander if he informs the umpi



a, b, c, etc., indicate successive plotted (observed) points
● ○ ○ " " set forward points
T_1 T_2 T_3 " " positions of towed target at instant of splash.

$B_3 = 61°45'$
$B_2 = 62°20'$
$B_1 = 63°40'$
$3)\underline{186°\ 105'}$
$B = 62°\ 35'$

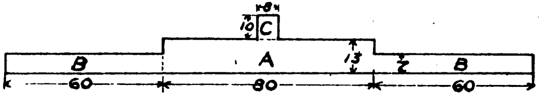
Plotting board plot.

Lines of direction and two datum points should be drawn on original plot by range officer before it is moved.

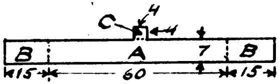
PLOTTING BOARD PLOT.

COAST ARTILLERY TARGETS

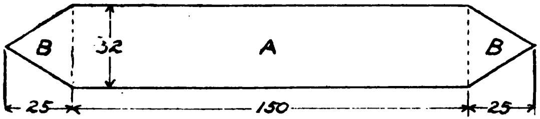
Form 1000. Target for 8-in., 10-in., 12-in., 14-in., and 16-in. Guns.



Form 1000A. Target for 5-in. and 6-in. Guns. (1st Practice)



Form 1001. Target for Mortars



Value of hits in sections
A = Full hit
B = ½ hit
C = ½ hit

All dimensions in yards

COAST ARTILLERY TARGETS.

For a gun battery (Target Forms 1000 and 1000A) a shot 10 yards or les short, measured parallel to line of direction, whose splash intersects the waterline of the target, is a hit with value corresponding to the section of the waterline intersected.

For rapid fire guns (and 5″ and 6″, except for practice), the target is a material target 10 feet high and 24 feet long.

district commander. He determines by inspection the hits on rapid-fire targets, and from the records decides hits for all other batteries. He makes report to the coast defense commander, stating whether or not the practice has been carried out in accordance with the regulations, and reports in detail all irregularities. He is assisted by one officer and two non-commissioned officers to act as time keepers, one officer and two non-commissioned officers as observers for lateral deviations, and one officer as tug officer; all are detailed by the coast defense commander, and report to the umpire for instructions.

The umpire will impose a penalty of 5% of the figure of merit if the firing of a mortar battery is suspended on account of excessive lateral deviation and such is found to be due to the personnel.

CONDUCT OF PRACTICE.

121. For regular troops, target practice is conducted in accordance with prescribed regulations. For National Gaurd troops, the inspector-instructor has entire charge of the practice, and is authorized to depart from the regulations when considered necessary. The slopes should always be well watered before firing.

Two guns will be used for each gun battery, and fired alternately; for mortars, pits will be fired alternately, in salvos of two. The pieces fired the least will be selected. The inferior corrected range for guns will approximate 6,000 yards for 5-inch and 6-inch, 8,000 yards for 8-inch, and 10,000 yards for 10-inch and above; for mortars, the two outer zones will be used.

With breech open and projectiles on trucks (on barbette carriages, one projectile on hoist at height of breech), the authorized commands for firing (see Chapter VIII) may be given when three successive ranges are plotted on time range-board. The splashes are observed by the battery commander (or his assistant) with a telescopic sight or azimuth instrument containing a movable wire or pointer, the angular deviation being determined as follows: The fixed wire set at 3.00 is kept on target, and when the splash occurs, the instrument is halted and the movable wire is run to the splash; this reading of the splash is set off on the arbitrary deflection scale of the deflection board, and acts to throw the next splash on the target. The observing instrument is then kept on this reading of splash (instead of 3.00) for the next splash, and the operation repeated. To prevent delay, the battery commander should announce to the gun pointer the proper setting of the sight, remembering that increasing the numbers throws the next splash to the right, and *vice versa*. When an azimuth instrument without a movable pointer is used, this angular deviation is the difference between the azimuth of target and azimuth of splash, a decrease in the sight deflection or the deflection correction throwing the next splash farther to the left, and *vice versa*. When instrumental observation of fire shows that shots are not falling properly, range corrections can be made for mortars as explained in paragraph 113. and for guns by applying an arbitrary correction either on range board or time-range board.

On resuming the fire after an interruption, the arrangement of personnel and matériel should be the same as when **CEASE FIRING** was given.

TARGET PRACTICE REPORTS.

122. Before any firings are conducted, the battery commander will secure a full set of service or subcaliber practice forms, and will have records kept of all data transmitted and received over all lines of communication and other data needed on said forms. Forms convenient for these records are shown in "Artillery Notes No. 38," and are printed at the forts.

Form 819-A for guns (B for mortars, C for fire commands); prepared by battery commander. Five copies to coast defense commander, who forwards one copy through channels to A. G. O., War Department, and one copy each to armament officer for Chief of Ordnance, district headquarters, battery emplacement book, and organization firing. Accompanying the copy for the A. G. O. will be the report of analysis board, plotting of splashes, and photographs. A copy of analysis report will also be provided district headquarters and company records.

Form 821; prepared by range officer—one copy to battery commander, for file with the company records.

Form 822; prepared by observer for lateral deviations—one copy, through umpire, to battery commander, for file with company records.

Form 823; prepared by tug officer—one copy, through umpire, to battery commander, for file with company records.

Form 833; prepared by time keeper—one copy, through umpire, to battery commander, for file with company records.

Form 834; prepared by emplacement officer—one copy to battery commander, for file with company records.

Form 831 (subcaliber firing); two copies of each practice, prepared by battery commander, to C. D. commander, who forwards one copy to the armament officer for the Chief of Ordnance and one for emplacement book. One report may cover firings extending throughout entire militia exercises.

Data for Target Practice Reports.

123. Forms 819 and 821. **The (actual) range and approximate or uncorrected azimuth to set-forward point (or target) for** guns and mortars is the gun arm range and azimuth to the mean line drawn through the observed points which represent the course of target, when the gun arm is placed on position of target at instant of splash. To verify the position of target, the plotter should, when he hears a shot fired, mark the course, showing its approximate position.

Projectile struck referred to target, overs and shorts. These are longitudinal deviations obtained from the cross-section plot by plotting the camera records of Form 823. Observe that splashes on cross-section cut measure + 38 yards. The rights and lefts are lateral deviations obtained from Form 822.

Forms 819 and 834. The **corrected range** is obtained by applying the gun difference and level correction to the marked range drum setting when the piece was fired; the correction has to be applied in a direction opposite to that used when the gun was laid. The azimuth subscale should also be marked.

The **corrected elevation** is obtained by marking the auxiliary elevation scale.

The **mean corrected range** is the mean of the sum of the corrected ranges used.

Form 822. The angle between towed target and splash is measured on shore with a telescopic sight; the sight set at 3.00 is kept on target until the splash appears, when the movable wire is run to middle of splash. This angle is converted into yards at target perpendicular to line of observation by multiplying its tangent by the distance between observer and target, as determined from plotting board.

Form 823. The angle between towed target and splash is measured on tug, both with range rake and camera (the latter generally being more reliable), as follows:

1. The normal of rake is kept on target and the deviation of splash in mils, right or left, is read on the cross-arm below the edge of splash nearest the battery

Mil.—One yard at 1,000 yards, two yards at 2,000 yards, etc., subtends an angle of 3.41 minutes and is called a "mil." For purposes of rapid conversion from linear measures to angular measures, this amount is taken as .05°, but this equivalent is only an approximation. To convert mils into yards at any distance, multiply the number of mils by the distance from observer to target and divide by 1,000. Thus, suppose the range rake reading of a splash, taken from the tug, is 25 mils, and the tow line is 300 yards long; then 25 × 300 ÷ 1,000 = 7.5 yards; 7.5 yards when laid off from target perpendicular to tow line, and a line drawn from this position so determined to the tug will contain the splash. Note that this distance is not generally the longitudinal deviation.

2. The camera is snapped to take in target and splash, and the distance between them is determined from the film with the aid of a film scale and tangent scale. The film scale is the scale of the service camera, usually 6.32 inches = 140 yards (corrected

for tilting of camera), and was constructed by photographing stakes set at measured intervals apart 100 yards from the camera.

The method is as follows:

Place upper edge of film scale parallel to horizon with its zero on the geometrical center of film (intersection of diagonals); read the displacements, in yards, of target and edge of splash nearest the battery. If the geometrical center of film is below the water line of target, hold film upside down.

The displacements thus determined refer to the axis of camera; they are referred to course of tug as follows: (*a*) **Geometric center between target and splash:** Set the zero of inner scale to number on outer scale equal to displacement of splash; then opposite number on inner scale equal to displacement of target is read on outer scale the distance between splash and target. (*b*) **Geometric center on same side of target and splash:** Set the lesser of the displacements on the inner scale opposite the greater displacement on outer scale; then on the outer scale, opposite the zero of the inner scale, is read the distance between splash and target.

The distances just determined are for towlines 100 yards long, and must be multiplied by the length of towline used and divided by 100, in order to refer them to the target perpendicular to course of tug.

CHAPTER XII.

EXAMINATIONS FOR OFFICERS.

These examinations (written) are held on the second Monday in May and November of each year.

(NOTE.—Numbers after questions are references to paragraphs of text.)

BASIC COURSE.

(*a*) **Service of the Piece.**
  (1) Duties of each member of the gun section under all conditions.
    Chapters VII to XIV, D. R. C. A.

(*b*) **Gun and Carriage.**
  (1) Nomenclature, purpose and action of the principal parts.
    Ordnance pamphlets and "Gunners' Instruction."
  (2) Packing stuffing boxes.
    Ordnance pamphlets and "Gunners' Instruction."
  (3) Cleaning recoil cylinders.
    Ordnance pamphlets and paragraph 452, D. R. C. A.
  (4) Adjustment of grease cups.
    Paragraph 444, D. R. C. A.
  (5) Dismantling breechblocks.
    Paragraph 453, D. R. C. A., and Ordnance pamphlets.
  (6) Adjustment of gas check pad.
    Paragraph 457, D. R. C. A.
  (7) Adjustment of firing mechanism.
    Ordnance pamphlets and "Gunners' Instruction."
  (8) Oiling and painting.
    Paragraphs 423 to 433, D. R. C. A.

(*c*) **Powders, Projectiles, Fuses, and Primers.**
  (1) A general knowledge of the mâtériel pertaining to the battery to which assigned.
  (2) Preparation of charges.
    Ordnance pamphlets and C. A. I. O.
  (3) Painting of projectiles.
    Ordnance pamphlets and "Gunners' Instruction."
  (4) General instructions for storage and care of explosives.
    Paragraphs 478 to 494, D. R. C. A.

(*d*) **Cordage, Tackles, Gins, Sheers, and Jacks.**
  "Gunners' Instruction" and Chapter XI, S. C. A.

(*e*) **Fire Direction.**
  (1) A general knowledge of the range and position finding systems for batteries of the major armament.
    Chapter V, D. R. C. A., and C. A. M.

(*f*) **Pointing.**

(1) A general knowledge of the use of the telescopic sight for guns.

Ordnance pamphlets, "Gunners' Instruction," and S. C. A.

(2) A general knowledge of the use of the gunner's quadrant for mortars.

Ordnance pamphlets, "Gunners' Instruction," and S. C. A.

(*g*) **Characteristic Features of the Different Classes of Warships.**

"Gunners' Instruction."

(*h*) **Definitions, Drill Regulations for Coast Artillery.**

Chapter XXVI, D. R. C. A.

(*i*) **United States Rifle.**

"Gunners' Instruction."

(*j*) **Care of Troops.**

(1) On the march.

Paragraphs 623 to 635, I. D. R., 1911.

(2) In camp.

Paragraphs 661 to 677, I. D. R., 1911

BASIC COURSE QUESTIONS.

(*a*) Service of the Piece.

What is the strength of a gun (or pit) section, and into what detachments and details is it divided?

Prepare a table showing the duties of each member of a gun (or mortar) detachment for: "Details Posts"; "Examine Gun"; "Load"; "Cease Firing."

Make a sketch showing the post of each member of the gun (or mortar) detachment at the piece.

Explain how to post the gun (or pit) section.

What is the strength of the ammunition and reserve detachments? and state briefly their duties.

Give the commands to load and fire.

What are the duties of the gun (or pit) commander when loading and firing?

What is done at the command "Relay" (gun or mortar), and "Take Cover"?

Explain the duties of the range setter.

Explain how to retract the gun; how to open breech.

(Ref., "Gunners' Instruction" or D. R. C. A., Chapters VII to XIV.)

(*b*) Gun and Carriage.

Name and describe the important parts of the carriage selected, beginning with the parts bolted to the concrete—their purpose and action.

State the material of which the gun (or mortar) is made; the general type of construction, location and names of parts; length in calibers, weight of projectile; weight of powder charge, and normal muzzle velocity.

Describe briefly the following parts of the gun (or mortar) carriage at your battery: base ring; racer; recoil cylinders; traversing mechanism; breechblock; tube.

Name, illustrate by diagram or sketch, and explain the action of the parts of the breech mechanism designed to prevent the escape of powder gas.

Prepare a rough sketch showing a longitudinal section of the gun (or mortar) to which assigned; indicate and name thereon all the principal parts, to include all cavities and slopes. **(25, 26, 31, and G. I.)**

Describe the counter-recoil system of the carriage at your battery, and state its function; how the energy of recoil is taken up; how the flow of oil is controlled when the gun (or mortar) is fired; what to do if the gun recoil to the buffers on firing. **(38.)**

Should the cylinders ever be allowed to remain empty, and why? **(38.)**

Explain how to unpack, pack, and adjust a stuffing box; what material is used, and how much. **(39.)**

When should the recoil cylinders be cleaned, and how? **(36.)**

What is a grease cup, and how is one packed and adjusted? Describe lubricant No. 4½ and state reasons for using such a lubricant. **(37.)**

Explain how to dismantle and assemble the breechblock of a heavy cannon. When is it dismantled, and why? **(27, 103.)**

Desribe the treatment and adjustment of the gas check pad. **(26.)** How is the firing mechanism tested? **(108.)**

Describe the operation of assembling the firing mechanism, and name parts, giving function of each part. **(29.)**

Name the oils used at a battery and state the purpose of each.

Explain the method of painting guns (or mortars) and carriages; the color used, and the parts left unpainted.

Explain the method of removing paint.

Explain the method of marking guns (or mortars and pits). **(40.)**

(*c*) Powders, Projectiles, Fuses, and Primers.

Describe the shovel and cycle method of blending powder; under whose supervision it is done, and the care that should be taken.

How are powder charges remade after blending? What precautions must be observed in handling them?

What is the object of blending powder?

Describe a method of making a compound blend of three lots of powder. **(20.)** What are delay and non-delay action fuses and their uses?

Name the different kinds of primers and fuses, and explain briefly the purpose and action of each. **(17, 18.)**

Sketch an armor-piercing shot and shell, showing the two caps of each? What is the purpose of each cap?

State the colors used, and what these colors and their positions indicate, for the following: (1) A. P. shot, filled and fused; (2) A. P. shell filled and fused; (3) cast-iron projectile. **(22.)**

Explain the regulations governing the storage of powders and explosives.

What inspections of powders and explosives are required?

What safety precautions are necessary in handling and caring for powders and explosives? Where are the keys to the magazine kept?

Explain how to determine when to ventilate magazines, and the necessity therefor.

How are powders and projectiles stored in the magazines?

Describe the container of a powder charge. **(19, 21.)**

(*d*) Cordage, Tackles, Gins, Shears, and Jacks.

What is the difference between a thief knot, a granny knot, and a square knot?

How should rope be stored and coiled? How is the size denoted?

For what purpose are each of the following used: cat's-paw; bowline on a bight; Blackwall hitch; sheep-shank?

What is seizing; whipping; parceling; mousing; serving?

What is the bight of a rope?

For what purpose are the following used: rolling hitch; Carrick bend; sheep-shank; clove hitch; square knot?

Define rope and marlin. **(94.)**

When should you use a gin, hydraulic jack, shears, or crane?

Explain how to assemble and erect a garrison gin.

Explain how to assemble and erect shears. **(97, 98.)**

Make a rough sketch of the following tackle, giving the power in each case, disregarding friction: whip; gun tackle; luff tackle. What is meant by "power of tackle"? **(96.)**

Describe the hydraulic jack. State the principles of its operation; the purpose for which it is used; the different kinds, and how each are used; and the use of the claw. **(98.)**

(*e*) Fire Direction.

Describe the systems of position finding. Which is normal? **(63.)**

Draw a diagram showing the following: horizontal base; directing point of a battery of two guns; battery commander's station; auxiliary base; emergency base.

Google

Name the several appliances and devices in the plotting room, and state the object of each.

What instrument are necessary for the various systems of range finding? (**44, 63.**)

Explain briefly how the corrected range of the target is determined from the time the horizontal base begins tracking until the data are sent to the guns. (**55.**)

What observing and aiming points are used? (**48.**)

Give commands for indicating a target and tracking, for the various systems. What is done by observer and gun pointer?

Four warships are coming in the channel towards the battery, one behind the other; these ships are wide of beam, and each has three or more heavy gun turrets; give all commands required of the battery commander to direct the fire of the battery on the ship farthest away. (**48.**)

Explain the duties of each member of the range section at the command "Horizontal Base, Track." Same for vertical base, and emergency system. (**55, 56.**)

What are the manning parties for a B. C. station, plotting room, observing station? (**7.**)

What are the duties of the azimuth keeper, and where is his station? (**56.**)

How is drill conducted with the T. I. bell out of order? (**57.**)

(*f*) Pointing.

Explain Case I; Case II; Case III. Which is normally used at your battery? (**9.**)

Describe the telescopic sight; name the parts; show, with a sketch, the graduations of the deflection scale; and explain how the sight is attached to the mount and adjusted. (**8.**)

A gun is fired with a deflection of 3.25, and falls 0.15° right; what should be the correct deflection for the next shot?

A vessel is moving rapidly across the field of fire from left to right; there are no wind or drift corrections; will the deflection be greater or less than 3.00? (**121.**)

Describe the mortar quadrant and name the parts; to increase the range do you increase or decrease the elevation on the quadrant?

For what purpose is the quadrant used, and how is it tested? (**8.**)

A mortar is laid with the azimuth of what point? The (mortar) battery commander's telescope is set with the azimuth of what point? (**9, 55, 56.**)

(*g*) Characteristic Features of the Different Classes of Warships.

Give the distinguishing features of the following: armored cruiser; destroyer.

Give the general characteristics, including the armor and armament, of the following: battleships; armored cruisers; monitors; destroyers; gunboats

State briefly approximate maximum speed and usual draught of the following: battleships, cruisers, scouts, destroyers. **(99.)**

(*h*) Definitions, Drill Regulations for Coast Artillery.

Define the following: chase, tube, hoop, breech recess, bore, recoil cylinders, throttling valve, azimuth of a point (draw diagram), caliber, cap (draw diagram), Coast Artillery Militia, Coast Artillery Supports, danger space, elevation, observing interval, predicted point, set-forward point, deflection, jump, deviation, fire control, aiming, laying, bourrelet, obturator, erecting prisms, angle, base line, clinometer, directing point, quadrant elevation, line of direction, ammunition, angle of departure, battery, breech reinforce, gunnery. **(D. R. C. A.)**

(*i*) United States Rifle.

Name ten principal parts of the U. S. rifle.

Describe, in general, the method of cleaning the bore.

What parts should be kept oiled?

What is the caliber, range, and initial velocity of this rifle?

What kind of powder is in service ammunition, and what is the normal pressure?

What is the weight of the bullet?

How can service, dummy, and guard ammunition, caliber .30, be distinguished in the dark?

What is the object of the safety lock and cut-off?

Describe the rear sight; the different ways it may be used, and how to correct for wind. **(G. I. and Manual on Rifle.)**

(*j*) Care of Troops.

What should be done to protect the water supply?

What should be done to prepare troops for marching?

Under the head of "Marching," state the details that should be arranged for, the rate and time of march, the halts, and the use of water. **(I. D. R., pars. 623 to 635.)**

Give the qualifications of a good camp site.

Upon what does the health of all camps fundamentally depend?

State the conditions affecting the health of camps.

What are the duties of officers in connection with company or detachment kitchens in camp?

Discuss the care and sanitary inspection of camp and kitchen latrines.

Discuss the best methods of ridding kitchens of flies. **(I. D. R., pars. 661 to 677.)**

EMPLACEMENT COURSE.

(*a*) **Service at the Emplacements.**
  (1) General instructions.
    Paragraphs 203 to 217, D. R. C. A.
  (2) Bore sighting.
    Paragraphs 218 to 220, D. R. C. A.
  (3) Orientation of mortars.
    Paragraphs 221 to 222, D. R. C. A.
  (4) Methods of pointing,
    Paragraph 223, D. R. C. A., and "Gunners' Instruction."
  (5) Pointing tests for gun batteries.
    Paragraphs 224 to 226, D. R. C. A.
  (6) Prediction tests for mortar batteries.
    Paragraph 227, D. R. C. A.

(*b*) **Gun and Carriage.**
  (1) Care of guns and mortars.
    Paragraphs 434 to 451, D. R. C. A.
  (2) Adjustment of quadrant elevation device.
    S. C. A.
  (3) Setting of the recoil and buffer valve.
    Ordnance pamphlets.
  (4) Testing and adjustment of friction device.
    Ordnance pamphlets and W. D. orders.
  (5) Testing firing mechanism.
    "Gunners' Instruction."
  (6) Use of pressure gauges.
    Ordnance pamphlets and S. C. A.

(*c*) **Ammunition.**
  (1) Filling and fusing projectiles.
    Ordnance pamphlets and W. D. orders.
  (2) Storage and care of explosives.
    Chapter XXV, D. R. C. A.
  (3) Inspection of smokeless powder at forts.
    Paragraphs 560 to 566, D. R. C. A.
  (4) Care of empty metallic cases and primers.
    Paragraph 466, D. R. C. A.

(*d*) **Fire Direction.**
  (1) A detailed knowledge of the system employed at the battery to which assigned.
    Chapters V and VI, D. R. C. A.
  (2) Use of the time-range board.
    Paragraph 400, D. R. C. A.
  (3) Indication and identification of targets.
    Paragraphs 77 to 79, D. R. C. A.

(*e*) **Use of the Telephone.**

(1) Instruction of operators.

Paragraphs 367 to 372 and 377 to 379, D. R. C. A

(*f*) **Precautions for Safety at the Battery.**

(1) Responsibility of the emplacement officer.

Paragraphs 231 to 248, D. R. C. A., and Reminder List.

(*g*) **Conduct of Target Practice.**

(1) Duties of the emplacement officer.

Paragraphs 65 to 73, D. R. C. A., Reminder List, and C. A. I. O.

(2) Preparation of reports and records.

EMPLACEMENT COURSE QUESTIONS.

(*a*) Service at the Emplacements.

What are the requirements as to sponging? **(119.)**

Give the signals for the following, and explain what is done for each: elevate, right, clamp, halt, stand fast, take cover.

Explain the method of seating the projectile, and use of the powder tray? Why is care necessary? **(D. R. C. A. and G. I.)**

Explain the methods of bore sighting and orientation of guns and mortars. **(32.)**

Describe in detail the different methods of pointing, and use of each. **(9.)**

Describe, with examples, pointing test (gun) and prediction test (gun or mortar). **(10.)**

(*b*) Gun and Carriage.

What treatment is given guns and carriages to prevent rust and insure their being in working order?

Explain how oil is applied and removed from the bore.

What is the habitual position of guns and mortars?

Give the use of the different oils, and explain how each is applied. **(40.)**

Why is oil removed from the bore previous to firing? **(104.)**

What treatment is given the bore and breech mechanism after firing? **(103.)**

Where are grease cups found on the carriage? Name the lubricant used and the necessity for this kind of lubrication.

How are grease cups filled and adjusted? **(37.)**

How often are mortars raised from their trunnion beds? Explain the method of dismounting guns and mortars, and how to remove the piston rod. What material is used? **(35, 36.)**

How is the quadrant elevation device on gun or mortar tested for adjustment?

Explain how to test the base ring for level, and make corrections therefor.

What is a clinometer, and how is it adjusted and used?

How is the mortar quadrant adjusted when the clinometer does not read to 45°? **(33.)**

Describe briefly the recoil system and valves of the gun or mortar carriage, and its function.

Describe in detail how to determine the proper setting of the throttling and buffer valves.

Name the important parts of a carriage and their functions.

What should be done when the mortar returns to the firing position with too much shock? when it does not fully return? **(38.)**

Explain the object of and the method of adjusting the friction device of the elevating mechanism of your carriage. **(34.)**

Explain how to assemble and test the firing mechanism on the gun or mortar.

What are the regulations concerning the care and use of the firing mechanism? **(29.)**

Describe the pressure gauge, give the principle involved, and explain how they are prepared for use. State the current regulations in regard to taking of pressures in target practice. (Problem to be solved by candidate.) **(24, 106.)**

(*c*) Ammunition.

Give briefly the method of filling and fusing projectiles. **(23.)**

State the regulations governing the handling and storage of explosives. **(21.)**

Explosive "D," black powder, dynamite, wet guncotton, and smokeless powder are all on hand at a battery; how should each be stored, and what precautions taken in each case?

It is required to place in storage the following explosives: wet guncotton; smokeless powder; small amount of dry guncotton left over from filling fuse cans; explosive "D"; detonating fuses; primers; dynamite; black powder; commercial detonators. There are available magazines D and D′, which are dry, and magazine W, which is wet; also an isolated dry house which can be securely locked. Where should the different items be stored, and what precautions should be observed in handling and piling each?

How should explosive "D," smokeless powder, fuses, primers, and projectiles filled and fused, be stored and cared for?

Group the following explosives for storage in a minimum number of rooms: wet guncotton; commercial detonators; smokeless powder; dry gun cotton; fuses; explosive "D"; primers; dynamite; trotol; and black powder. **(21.)**

Explain how to determine when magazines shall be opened for ventilation. Why are they ventilated?

What is the maximum allowable temperature for a powder magazine, and what action should be taken when this maximum is reached?

It is an exceptionally warm day in early spring; the barometer s very low; should a magazine be opened for ventilation, and why?

Describe the tests and inspections required by an officer charged with the care of powders and explosives. **(21.)**

What treatment is given primers and empty subcaliber cartridge-cases after they are fired? **(18, 102.)**

How are smokeless powder storage cases opened, sealed, and stored? **(19, 20, 21.)**

(*d*) Fire Direction.

Describe the systems of position finding. Which is normal? **(63.)**

Give the manning parties of the B. C. station, observing station, and plotting room. **(7.)**

Give the commands for assigning and tracking a target, to observers and gun pointers, and explain each command. **(48.)**

Explain in detail the duties of the range section when tracking with the various systems. **(55, 56.)**

What observing and aiming points are used? **(48.)**

Describe the method improvised at the mortar battery for the detection of excessive errors in azimuth. Describe a simple method in a mortar pit to indicate an erroneous azimuth setting. **(56, Note.)**

Explain the duties of the range recorder or booth detail.

Describe the time-range board and explain how it is used. **(77 and G. I.)**

Describe the method employed by the battery commander to insure the guns being laid on the target designated. **(48.)**

(*e*) Use of the Telephone.

What care should be taken in the selection of telephone operators? Outline method to be followed in selecting them.

What rules should be observed in sending and receiving messages by telephone?

What care should a telephone operator take of his instrument?

Explain how to open and close a station. **(71.)**

(*f*) Precautions for Safety at the Battery.

How long should target practice ammunition be stored in the service magazine before practice, and why is this requirement?

How are projectiles prepared for service practice?

The maximum diameters at the rotating bands at the rear of six projectiles are as follows: 6.347, 6.340, 6.338, 6.345, 6.343, and 6.339; in your judgment, which of these should be used for trial shots, and why? **(104.)**

During target practice, what precautions must be observed about flags or signals displayed on the shore?

Who is responsible for all the necessary precautions of safety at the battery?

What is done to prevent injury to ear-drums?

The emplacement officer receives orders from his battery commander to commence firing, but he judges the range to be unsafe; what action should he take?

What are the precautions for safety at the battery?

State in detail how the mushroom head and powder chamber are treated after each shot during service practice. Why is this required?

When is the primer inserted and removed, and when is the lanyard hooked?

In case of misfire by lanyard, what is done? Same for electric firing. **(119.)**

State the regulations and safety precautions governing the firing of salutes. **(84.)**

(*g*) Conduct of Target Practice.

What are the duties of the emplacement officer prior to practice and during and after practice? **(5, 81, 119.)**

Who is responsible for the safety of the field of fire at battery service practice?

What are the instructions relative to amount of powder and projectiles on the loading platform during practice? **(119.)**

How, and by whom are deflection corrections determined? Is the gun pointer permitted to apply any deflection corrections based on his own observation of the fall of projectiles?

Actual range to target, 8,500 yards; deflection used for first shot, 3.50; first shot was fired and fell 0.45° to the right of the target. Required: the lateral deviation in yards and the deflection for the next shot. **(112, 121.)**

What is done at a mortar battery if a shot falls near the tug?

How is the pit data used and checked? and explain a method of detecting azimuth errors. **(119 and 56, Note.)**

What is the object of subcaliber practice? Explain how the tube is inserted and adjusted, and give the annual allowance of subcaliber ammunition. **(100, 101.)**

At the conclusion of battery service practice, what report is submitted by the emplacement officer, how many copies are made, to whom is it submitted, and where is its ultimate destination?

What data go on the battery (emplacement) officer's report, trial and record shots, and what provision has to be made to collect these data, and how are they obtained? **(122, 123.)**

What preparations are necessary for service and subcaliber practice? **(100-111.)**

RANGE COURSE.

(*a*) **Fire Direction.**
  - (1) A detailed knowledge of all systems of range and position finding for mortar batteries or for gun batteries of the major armament.
    Chapter V, D. R. C. A.
  - (2) Indication and identification of targets.
    Paragraphs 77 to 79, D. R. C. A.

(*b*) **Fire Control Apparatus.**
  - (1) A detailed knowledge of the use, care, and adjustment of all apparatus pertaining to the fire control installation of a fort.
    Chapter XXIII, D. R. C. A., and Signal Corps Manual No. 8, and C. A. M.

(*c*) **Telephone Service.**
  - (1) A detailed knowledge of the use and care of telephones.
    Paragraphs 367 to 372 and 377 to 379, D. R. C. A., and Signal Corps Manual No. 8.
  - (2) A general knowledge of the testing of service telephones.
    Paragraphs 373 to 376, D. R. C. A., and Signal Corps Manual No. 8.

(*d*) **Elementary Gunnery.**
  - (1) Explanation of the corrections to be applied to the observed range to obtain the corrected range.
    Chapter XXIII, D. R. C. A., and S. C. A.
  - (2) Effect on the flight of the projectile of variations in the density of the air, the direction and velocity of the wind.
    Chapter XXIII, D. R. C. A., and S. C. A.
  - (3) Use of trial shots.
    Chapter XXIII, D. R. C. A., and C. A. I. O.

(*e*) **Signals.**
  - (1) Knowledge of the system employed between tug and shore during Coast Artillery drill and target practice.
    Reminder List and "Shore-Tug Signaling."

(*f*) **Conduct of Target Practice.**
  - (1) Duties of the range officer.
    Paragraphs 57 to 64, D. R. C. A., Reminder List, and C. A. I. O.
  - (2) Preparation of report and records.

RANGE COURSE QUESTIONS.

(*a*) Fire Direction.

Describe the various systems of position finding. What stations and commands are required in each system, and what fire control apparatus are required in each station. **(93, 63, 44.)**

Prepare a manning table for the following: battery commander's station; plotting room; observing station; emergency station. (7.) What are salvo points? When and how are they used? **(60.)**

What are the responsibilities of the range officer at drill, practice, or action, and what inspection and report does he make before the commencement of drill, practice, or action? **(81, 103.)**

What is done when the time-interval bell fails to work? **(57, Note.)** The B. C. instrument is how used in Cases II. and III.? **(55, 121.)**

Name the fire control equipment in the plotting room of your battery. **(44.)**

How many kinds of travel are determined in a plotting room, how are they determined, and when are they used? **(55.)**

What is done to shift from horizontal to vertical base?

Define predicted and set-forward points and explain how they are determined.

What is meant by "corrected range"? How is it obtained and used when tracking with horizontal base, vertical base, and emergency system? Give duties of all personnel. **(55, 56.)**

What is meant by emergency system, and when is it used? **(63.)**

Name two methods by which a target may be indicated by the battery commander to the ooservers at B′ and B″.

How can the battery commander determine if the observers are on the same target?

Give commands for indicating and tracking a target to observers and gun pointers, and explain each command.

What observing and aiming points are ordinarily used? **(48.)**

(*b*) Fire Control Apparatus.

Describe the gun deflection board, and explain its operation both in Case II. and Case III.

Explain how a deflection correction, based on the fall of a shot, is determined and applied. **(45, 112.)**

Describe the mortar deflection board, and explain its operation.

Describe the battery commander's observing instrument. How is it adjusted, and when and now is it used? **(45, 57, 121.)**

Explain how to test a plotting board to determine if it is in adjustment for azimuth and range.

What is the diagonal scale on the plotting board, and when is it used?

What graduations appear on the mortar arm and on the zone scale?

Describe briefly the various steps in orienting and adjusting the plotting board (gun or mortar).

Describe the Whistler-Hearn plotting board.

Explain how to check the mechanical accuracy of the plotting board by use of the three hypothetical points.

A plotting board is right-handed; the azimuth of B″ from B′ is 89.68°; what is the azimuth of the normal of the board? **(52.)**

Explain the adjustment of the D. P. F. (Lewis or Swasey) for range and azimuth.

Give the observer's test, using D. P. F. What accuracy is expected? **(57, 59, 60.)**

Explain how to set up and adjust the azimuth instrument so that it will indicate correct azimuths. **(61.)**

Where are time-interval bells installed? Explain the time-interval system. **(76.)** Operate and explain wind component indicator. **(72.)**

What changes are necessary in the plotting room apparatus to change from service to subcaliber practice? **(100.)**

Describe the atmosphere slide rule; explain its use. **(42.)**

Describe the range board; explain the adjustments necessary, and its operation. **(67.)**

Describe the wind component indicator; explain its use. **(72.)**

Describe the time range board, or chart; explain its use. **(77.)**

(*c*) Telephone Service.

State the rules to be observed by operators in receiving and sending messages over the telephone; give examples, sending range and azimuth.

How does an operator open and close his station?

How are telephone operators selected and tested?

What care should be given a telephone?

Draw a sketch showing the circuits of a telephone system.

Name the parts in a telephone and state the object of each.

What is the function of the retardation coil?

Give the tests of a telephone which can be made without any apparatus other than those found in any fire control station.

Name and describe the test a telephone operator is expected to apply to his instrument.

What are the principal troubles occurring in telephones? State the cause and determination of each and the corrections. **(71.)**

(*d*) Elementary Gunnery.

Enumerate the corrections that must be applied to the observed range to obtain the corrected range; state by what piece of apparatus each correction is made.

What elements enter into a range correction, and from what source are the data for each derived? **(13 and Chap. V.)**

How is the range correction made for mortars? how for guns? **(13, 113.)** Define "danger space correction" and how applied. **(16.)**

What use is made of the barometer and thermometer readings, and how are they applied? **(13.)**

What is the daily message, and where does it come from? **(81.)**

Assume the center of impact of a series of trial shots is 100 yards "over" the target; when this error is applied to the range board will the resulting record shot velocity be greater or less than the assumed trial shot velocity? **(14, 67.)**

The average lateral deviation of a series of trial shots is 0.35° to the right of the target; how is this information used to correct the deflection for record shots? Will it be an additive or subtractive correction? **(14, 112.)** What is a mil? **(123.)**

Trial shots are fired (12-inch) on following data: actual range of target, 7940; atmosphere reference number, 16.80; wind reference number, 46.0; tide, 0; velocity, 2352; corrected range sent to guns, 7380. Using range board, verify the corrected range as sent to the guns. **(67.)**

Result of four trial shots: No. 1, +64; No. 2, +29; No. 3, +82; No. 4, +3 yards. Required: (1) What difference in range will be used for entering the range board to determine velocity for record shots? (2) Using range board and muzzle velocity chart determine velocity for record shots. **(14, 67.)**

Note.—If no range board is available, explain in writing how the velocity is determined for record.

Three trial-shots are fired: the center of impact is 8500 yards; the aiming point was at a range of 8900 yards. (*a*) What instruments are used in determining the velocity developed by trial shots? (*b*) Was the velocity assumed for the trial shots too low? (*c*) If the temperature of the powder changes before the record shots are fired, what correction will be necessary? **(14, 67.)**

Explain the use of the muzzle velocity chart. **(49.)**

How many zones are there for mortar service and subcaliber practice? What is an overlap? Give its extent. **(8.)**

(*e*) Signals.

Describe the method of signaling between tug and battery.

For service practice and drill, how is communication between shore and tug habitually established, and what are the several signals used? Signals regarding range refer to tug or target?

How does the towing vessel acknowledge signals? **(86.)**

State the use of the red flag used on the towing vessel and at the battery, in connection with service and subcaliber practice. **(86, 119.)**

(*f*) Conduct of Target Practice.

What are the duties of the range officer before, during, and after practice? **(81, 103.)**

Explain how the data for trial shots are determined, and how they are located on the plotting board. **(111, 112.)**

Explain the method of plotting splashes for the determination of hits. **(114, 115, 116.)**

At the conclusion of battery service practice, what target practice report is submitted by the range officer? how many copies are required? to whom are they submitted? and where is its ultimate destination? **(122.)**

What data are contained on the report submitted by the range officer? and how is each obtained? **(123.)**

What is done by the range officer, as regards the plot for service practice, immediately after the practice? **(114.)**

Who determines the range and deflection corrections in service practice, and how is it done? **(121.)**

BATTERY COMMANDER COURSE.

(*a*) **Company Formations and Marching Maneuvers.**
  Chapter III, D. R. C. A.
(*b*) **The Battery Command.**
  Chapter IV, D. R. C. A.
(*c*) **Fire Direction for Batteries of the Armament to Which Assigned.**
  D. R. C. A.
(*d*) **Conduct of Target Practice.**
  (1) Duties of the battery commander.
    Chapter XVI, D. R. C. A., Reminder List, and C. A. I. O.
  (2) Trial shots.
    C. A. I. O. and C. A. M.
  (3) Information obtained from range tables.
  (4) Preparation of reports and records.
(*e*) **Care of Matériel.**
  Chapter XXIV, D. R. C. A.
(*f*) **Coast Artillery Inspection.**
  Chapter XX, D. R. C. A.
(*g*) **United States Army Regulations.**
  (1) Company administration.
    Article XXX (Edition of 1913).

BATTERY COMMANDER COURSE QUESTIONS.

(*a*) Company Formations and Marching Maneuvers.

State in detail how a company is formed for artillery drill.

Prepare a diagram showing in detail the positions of the officers, non-commissioned officers, rated men, sections, and details in a company when it is formed preparatory to marching to the battery. **(78.)**

Explain how to post the sections. **(80.)**

What reports are made to the battery commander, and by whom are they made?

The various sections having arrived at their posts, what examinations and inspections are made, and what reports are rendered? **(81.)**

Explain how an inspection (artillery) in ranks is conducted. **(79.)**

Give commands for: (1) Marching a company to and from the battery; (2) posting the details and sections; (3) discontinuing drill and returning the company to its quarters. **(80.)**

(*b*) The Battery Command.

Give in general terms the battery commander's responsibilities with respect to the efficiency of the personnel and matériel. **(5, 82.)**

In case one base-end station goes out, what action does the battery commander take in order to continue his battery in action? **(63, 100.)**

Under what conditions is the battery commander authorized to modify the manual of the piece as prescribed by D. R. C. A.?

Under what conditions is the battery commander authorized to make temporary changes in the fire control installation? What is the procedure for using a new device at the battery? **(5.)**

How should observers for D. P. F.s be selected? **(57.)**

For what are emplacement and range officers responsible to the battery commander? What are their duties preparatory to drill or practice, and also after? **(5, 81.)**

What are the duties and responsibilities of the plotter, gun commander, gun pointer, and mechanics, before and during drill, and also after drill? **(5, 81.)**

Give all commands, from the battery commander down, to discontinue drill. **(81, 93.)**

State the emergency conditions under which drill should be conducted. **(100.)**

(*c*) Fire Direction for Batteries of the Armament to Which Assigned.

Explain the different systems of range finding, and stations and equipments necessary for each.

Describe what may constitute an auxiliary base.

Draw a diagram showing the following: battery of two guns (or two pits of four mortars each); horizontal base; battery commander's station; auxiliary base; emergency base; lines of communication. **(63, 44.)**

Prepare a manning table for the following: battery commander's station; plotting room; observing station; emergency station. **(7.)**

Give commands for indicating and tracking targets, and explain each command.

What observing and aiming points are used?

Give the commands of the B. C. (1) for tracking by horizontal base; (2) for changing to vertical base at B′; (3) for changing to vertical base at B″; (4) for changing to auxiliary base system (B′ or B″); (5) for changing to emergency system; (6) for continuing tracking by horizontal base when B″ is destroyed; (7) for continuing tracking when the battery commander's station is destroyed.

How may a battery commander assure himself that the observers and gun pointers are on the same target? **(48, 93.)**

A battery commander receives the following command from the fire commander: "Target ——— **(name of subarea in battle area)** ——— Battleship Division, Line Ahead, Ship No. 1, Commence Firing"; give the commands which will enable the battery commander to (1) open fire with armor-piercing shell; (2) continue fire after damage to B′; (3) continue fire after damage to B. C. station; (4) continue fire after damage to B″. **(93.)**

What is done in the B. C. station and pit to guard against errors in azimuth? **(56.)**

Explain the duties of each member of the range section when tracking by horizontal base, vertical base, and emergency system. **(55, 56, 57, 63.)**

What different kinds of travel are there? Explain how each is determined. **(55, 56.)**

When and by whom is the signal for firing (gun or mortar) given? **(9, 56.)**

When is the command "Relay" given the guns or pits? **(56.)**

(*d*) Conduct of Target Practice.

What inspections are required to be made by the battery commander before, during, and after battery serveice practice?

To what matériel should the battery commander pay special attention prior to service practice? **(103.)**

What special precautions are taken preparatory to night service practice? **(119.)**

What is the annual allowance of service and subcaliber ammunition for the battery to which you are assigned? **(105.)**

Name the different kinds of subcaliber practice and state the object of each. **(100.)**

In case of misfire during service practice, what should be done? **(119.)**

Upon whom does the responsibility for the safety of the field of fire rest during battery service practice? **(119.)**

What range and deflection corrections may be made from observation of fire, and how is each determined? **(121.)**

Discuss and explain compound blending of powder. **(20.)**

State the regulations as to sponging when firing service and blank ammunition. **(119, 84.)**

Discuss the subject of trial shots at battery service practice under the following heads: object, kind of target, range used at battery to which assigned, observing splashes and determining corrections therefrom, and number of pieces used. **(14, 111, 112.)**

What are the requirements regarding the taking of pressures? **(24, 106.)** Solve problem demonstrating use. **(24.)**

What are the different quantities that enter the figure of merit, and how and where is each obtained? **(118.)**

Assume data and explain by a sketch the method of plotting and determining hits for the guns or mortars to which assigned. **(117.)**

At the conclusion of battery service practice, what reports are submitted by the battery commander, how many copies are made, to whom are they submitted, and where is the ultimate destination of each? **(122.)**

For what reasons may "time out" be allowed? **(118, 120.)**

What are the limitations imposed by regulations upon ranges and the course of the target for all practices at the battery to which assigned for the current year? **(121.)**

Explain the several penalties that may be imposed by the umpire. **(120.)**

Describe the record targets for guns (or mortars). **(115.)**

What data not indicated on Form 819 is required? **(123.)**

(*e*) Care of Matériel.

Define: In service; out of service; in commission; out of commission. (Give examples.)

Name the oils and state the purposes of each.

State in general terms the parts of guns and carriages that are painted, the color used, and the parts that are kept free from paint.

Describe the methods and materials used in cleaning bores of guns and mortars, both before and after firing.

What is the habitual position of guns and mortars when not in use?

Discuss the care of the following: guns and carriages in daily use; guns and carriages not in use; telescopes; dummy projectiles; firing mechanism.

How is paint removed?

What are the regulations governing the marking of guns and emplacements? **(40.)**

How are empty cartridge cases and primer bodies cared for? **(18, 102.)**

How are recoil cylinders cleaned, and how often? **(36.)**

How is the gas check pad treated and adjusted? **(26.)**

(*f*) Coast Artillery Inspection.

Describe a battery inspection by a field officer, giving all commands, and state the items to which attention should be given.

What routine inspections are required of a battery commander? What procedure is followed to correct defects of matériel? **(83, 5.)**

(*g*) **United States Army Regulations (Article XXX).**

STAFF OFFICER COURSE.

(*a*) **Duties of the Communication Officer.**
    Chapter XVII, D. R. C. A.
(*b*) **Duties of the Personnel Officer.**
    Chapter XVIII, D. R. C. A.
(*c*) **Duties of the Matériel Officer.**
    Chapter XVIII, D. R. C. A., and C. A. M.
(*d*) **Searchlights.**
    (1) Care and operation.
        Chapter XXI, D. R. C. A., Artillery Notes No. 32.
    (2) Tactical use.
        Chapter XXI, D. R. C. A.
(*e*) **Means of Communication.**
    (1) Test of the telephones.
        Chapter XXII, D. R. C. A., and Signal Corps Manual No. 8.
    (2) Shore-tug signaling.
        Reminder List.
(*f*) **United States Army Regulations.**
    (1) Duties of staff officers in connection with the transportation and supply of troops *en route* and while in camp; transportation requests and ration returns.

STAFF OFFICER COURSE QUESTIONS.

(*a*) Duties of the Communication Officer.

What are the duties and responsibilities of the communication officer on manning the stations and during drill and practice? **(5.)**

Give the manning parties and equipment for the fire commander's station. **(7.)**

Give all commands for discontinuing drill through the fire command.

Give commands for assigning target to (1) Battery Parrott; (2) to all battery commanders. What are the different orders of fire?

What is "Fire commander's action" and "Battery commander's action," and when is each given? **(93.)**

What instruments are in the meteorological and tide stations? **(44.)**

(*b*) Duties of the Personnel Officer.

State the duties and responsibilities of the personnel officer on manning stations and during drill and practice. **(5.)**

Give the manning party and equipment for a fort command station. **(7.)**

Give commands for assigning target to (1) first fire command; (2) all fire commands. **(93.)**

What reports are received in a fort command station when opening station, and what instructions are given? **(81.)**

(*c*) Duties of the Matériel Officer.

What are the duties of the matériel officer both before and during drill? Where are the sources of the daily message?

Where is the station of the communication, personnel, and matériel officers? **(5, 90.)**

(*d*) Searchlights.

What are the standard searchlights in the service? **(90.)**

Where is the searchlight officer's station?

Give the manning party for each of the following: searchlight operated by central plant; by local steam plant; by local internal combustion engine.

What care should be taken of carbons to insure effective service?

What is an orientation table, and for what purpose is it used?

By means of what equipment in the searchlight officer's station does he control his lights?

Show by sketch what is done to spread or contract the beam?

Depending on their tactical use, how are searchlights classified. In what other way are they classified? **(90.)**

Give the approximate ranges at which a 36-inch light and a 60-inch light will illuminate a ship, painted navy gray, sufficiently well to permit tracking by the horizontal base system, under normal atmospheric conditions.

What report should be made when it is necessary to change carbons in a searchlight, and why?

Explain how a searchlight is put in action. How out?

Discuss the collective use of searchlights; the individual use.

What are the qualifications of searchlight personnel, and who trains them? When are illuminating and searchlights put in action?

Discuss fully and in detail the general requirements which govern the location and tactical use of searchlights acting in connection with fixed defenses. **(90.)**

Name the principal parts of a searchlight and explain the functions of the training and lamp mechanisms; state the shape and material of reflectors, the successive steps to replace carbons of a light in action, and describe the care of searchlights. **(90.)**

What are the regulations about searchlight beams coming on boats not provided for artillery purposes?

What is the object of: (1) battery night drill; (2) fire and fort command night drill? How is each conducted? **(92.)**

A searchlight officer gives the following command to No. 5 light: "Five, Raise." Is this command correct? If so, what does the light do? If not, explain and write the command correctly. The light is assumed to be in action when the command is given,

The command "Elevate," having been given to a searchlights by what command is the light again brought to the horizontal?

Explain what is done at the command "Search"; "Search Right"; "Search Bonita." Why is the command "Uncover" necessary?

Wherein are the following commands incorrect, if so: "Number Two in Action, Search Right, Halt, Cover, Follow"; "Three in Action, Search Buckroe, Cover, Follow"?

What is done at the following commands: "Two Out"; "Two, Cover Three"; "One, Search"; "One, Azimuth 275"; "Two, Elevate"? **(91, 93.)**

(*e*) Means of Communication.

How are telephone operators selected? **(71.)**

Explain how to open and close a station.

What are the rules for sending and receiving messages? How are the following sent: 4000; 5120; 4500; 231.10?

Enumerate the principal troubles occurring to telephones, and explain how to determine and locate each.

How is the telephone cared for?

Show by diagram the different circuits of a telephone.

Name the different parts of a telephone, and state the functions of each. What are common, local, dry, and storage batteries?

What are retardation coils for?

State the principle of a telephone.

Name the different kinds of telephones in the service.

What two classes of telephones are there? Name and briefly describe each. What is a composite telephone? **(71.)**

Describe briefly the standard night visual signaling equipment (acetylene lantern) furnished by the signal corps. **(89.)**

Describe the different methods of visual night signaling.

What are the signals habitually used between shore and tug in target practice, and how are they communicated?

What are the local means of signaling between tug and shore in the artillery district to which you are assigned? **(86.)**

Give the letters of the alphabet and the numerals from 1 to 10, inclusive, of the general service code. **(87.)**

How may the battery flag be used in service practice? in subcaliber practice? **(86, 119.)**

(*f*) United States Army Regulations.

What are the duties of staff officers in connection with the transportation and supply of troops *en route* and while in camp; transportation requests and ration returns.

FIRE AND FORT COMMANDER COURSE.

(*a*) **General Principles of Coast Defense.**
  Chapter I, D. R. C. A., and S. C. A.
(*b*) **Assignment of Personnel.**
  Chapter II, D. R. C. A.
(*c*) **Duties of the Fire Commander.**
  Chapter XVII, D. R. C. A., and C. A. I. O., and Reminder List.
(*d*) **Duties of the Fort Commander.**
  Chapter XVIII, D. R. C. A., and C. A. I. O., and Reminder List.
(*e*) **Conduct of Night Drill.**
  Chapter XXI, D. R. C. A.
(*f*) **Coast Artillery Inspection.**
  Chapter XX, D. R. C. A.
(*g*) **The Coast Artillery War Game.**
  (1) A general knowledge of its object and methods.
    "Coast Artillery War Game" (Chamberlaine).
(*h*) **Conduct of Target Practice.**
  (1) Duties of umpire.
    C. A. I. O. and Reminder List.
  (2) Analysis of firing.
    Artillery Notes No. 38.
(*i*) **The Coast Defense Command.**
  Chapter XIX, D. R. C. A.
(*j*) **United States Army Regulations.**
  (1) The Coast Artillery Corps.
    Article XXXI (Edition of 1913).
  (2) The Organized Militia.
    Article XLIV (Edition of 1913).

FIRE AND FORT COMMANDER COURSE QUESTIONS.

(*a*) General Principles of Coast Defense.

By what troops are the permanent fortifications of the United States manned?

What troops constitute coast artillery supports? coast guard?

Discuss what military preparations are usually made for the defense of the seacoast.

What two general classes of troops are called for by the scheme of coast defense, and what are the functions of each?

In the general scheme for the defense of the coast, what are the functions of (1) the coast artillery troops; (2) the coast artillery supports; (3) the coast guard; (4) the mobile army? (1.)

Discuss the considerations which govern the selection of points

Name those elements of permanent fortifications necessary for the effective service of the armament by day and night. **(4.)**

What guns constitute (1) the major armament; (2) the intermediate armament; (3) the minor armament? What is the role of each?

What two classes of armament are employed in coast defense? How does the caliber determine the classification? **(3.)**

Discuss the different forms of naval attack against a fort. **(2.)**

What is coast defense, and what military preparations are made on land for it? **(1.)**

What are the units of the tactical chain of coast artillery command? Explain briefly the function of each unit. **(4.)**

Discuss the relative value of guns ashore and afloat. **(99.)**

(*b*) Assignment of Personnel.

Give the manning table for: fort commander's station; fire commander's station.

What manning tables are required to be kept in the various stations of a coast defense command? Who makes them, and where does the personnel come from? **(6, 7.)**

Draw a diagram showing the various units in a coast defense command, with staffs and assistants of each commander. **(5.)**

What governs the assignment of companies to batteries, and officers to the various units of command? **(4, 5.)**

(*c*) Duties of the Fire Commander.

Prepare a manning table for the fire control system of a fire command. **(7.)**

Give two methods by which a target may be indicated by the fire commander to a battery commander. **(48, 93.)**

What are the duties and responsibilities of a fire commander?

What are the responsibilities of the fire commander before, during, and after practice, including any action necessary in regard to reports?

What action should a fire commander take when he receives the command "Fire Commander's Action"? **(5, 81.)**

What constitutes a fire command, and what considerations should govern the grouping of its components? **(4.)**

What is meant by restricted and unrestricted fire? **(5.)**

What commands should a fire commander give:

For Battery Parrott to fire one shot from one gun? **(93.)**

To open fire with Battery Parrott as soon as a previously assigned target reaches 7500-yard range?

To cause Battery Parrott to fire at five-minute intervals?

To fire with Battery Parrott successively at a division of ships from head to rear in column?

To require all guns of a battery to be loaded and held ready for action?

To turn over the action to the battery commander?

To fire at target illuminated by searchlight No. 7?

To designate a buoy as a fixed target, and order a ranging shot fired at same?

To assign as a target a division of dreadnoughts to the eastward of the battery, but not further restrict the initiative of the battery commander?

To require a pit salvo every three minutes at the leading ship of a bombarding division?

To have all batteries ready to open fire instantaneously on the leading vessel of a division coming in the main channel?

So that Battery Parrott will open fire upon the starboard ship of four battleships in line and will change, without further command, to the second, third, and fourth ships in succession as each ship in turn becomes disabled?

So that two out of three batteries will fire at the leading ship of a single column of battleships? **(93.)**

(*d*) Duties of the Fort Commander.

In what manner and by what command does the fort commander order unrestricted fire?

Give the commands to put in action (1) one fire command; (2) two out of three fire commands; (3) all fire commands. **(93.)**

How is the action of a fire command placed entirely in the hands of its fire commander? **(93.)**

Of what does a fort command consist? **(4.)**

Discuss the tactical and the administrative duties of a fort commander.

What are the duties and responsibilities of a fort commander?

What are general defense plans, and by whom are they prepared?

Under what conditions may a fort commander modify the prescribed manual of the piece? **(5.)**

Give the personnel constituting the fort command manning parties. **(7.)**

What conditions must be considered by a fort commander in arriving at an estimate of the situation preliminary to committing his command to action? **(2, 5.)**

(*e*) Conduct of Night Drill.

What is the general object of night drill?

How many different kinds of night drill are there? State the object of each. What personnel attends each?

What should be done by the fort commander to prepare his command for use at night?

What are the regulations about throwing searchlight beams

(f) Coast Artillery Inspection.

In making an inspection of a battery, what equipments, implements, and parts of guns, carriages, and emplacements should receive special attention? (83.)

Describe an artillery inspection of a fort command station, and name the apparatus that requires special attention. What action should be taken to ascertain if the personnel of the station was efficient?

Prepare a list of the principal items to be noted in a fire commander's inspection of his command.

Discuss fully and in detail the conduct of an "artillery inspection" so far as it relates to batteries and accessories thereto, and give all commands. (83.)

(g) The Coast Artillery War Game.

What is the object of the coast artillery war game? Describe briefly how it is played. **(See pamphlet on "War Game.")**

(h) Conduct of Target Practice.

What are the duties of the umpire at service target practice?

What penalties may be imposed by the umpire at service practice? (120.)

What are the duties and responsibilities of the fort commander and the fire commander in connection with service and subcaliber practice? (119.)

Name the different kinds of subcaliber practice, and state the object of each. (100.)

With whom does the responsibility for the safety of the field of fire rest at battery service practice? (119.)

What flags or signals are displayed on shore during target practice? (119, 86.)

What is the object of trial shots? Discuss how they are observed and plotted, and the data taken from them, and how it is used.

What persons are allowed in a fire control station during service practice? (119.)

State the meaning of the several quantities entering into the computation of the figure of merit for gun or mortar. (118.)

What inspections of breech and firing mechanisms are required? (103.)

Why should the bore be freed of oil before firing? (104.)

In action would more shot than shell be used, and why?

Why have rotating bands been widened? (22.)

What is the present tendency in the development of a type powder charge? Why is a change desirable? (19.)

Describe the operation of the fire commander's plotting board. (53.)

(*i*) The Coast Defense Command.

How is the artillery coast defense command established? **(4.)**

What constitutes the personnel of coast defense command headquarters?

What is an artillery district?

What rated positions are prescribed for coast artillery organizations?

How is the eligibility of candidates for such positions determined?

By whom and in what manner are the appointments to such positions made?

What non-commissioned staff officers are authorized for the Coast Artillery? **(4.)**

What are the duties of a coast defense commander? **(5, 119.)**

Who convenes analysis boards, and what are they for?

(*j*) United States Army Regulations (Article XLIV).

CHAPTER XIII.

EXAMINATIONS FOR RATED POSITIONS.

These examinations are oral and begin on the second Wednesday of February, May, and November of each year. Only 1st class gunners or men who have once qualified as such are eligible. For regulations governing appointments, see G. O. No. 22, W. D., 1914; G. O. No. 2, W. D., 1916; and D. R. C. A., 1914, page 196.

The allowance of rated men for each company is as follows: Gun company, one plotter, one observer 1st class, one observer 2d class, two gun commanders, and two gun pointers; mortar company, one plotter, one observer 1st class, two observers 2d class, and three gun commanders. Men in excess qualifying are carried on qualified lists for three years.

NOTE.—Questions in bold-face type were used in the oral examinations in February, May, and November, 1916. Numbers after questions are references to paragraphs of text.

GUN COMMANDER AND GUN POINTER.

(*a*) **Definitions, D. R. C. A.**

(*b*) **Gun and carriage.**

- (1) Nomenclature, purpose, and action of several parts.
  Ordnance pamphlets and "Gunners' Instruction."
- (2) Packing stuffing boxes and cleaning recoil cylinders.
  Ordnance pamphlets.
- (3) Adjustment of quadrant elevation device.
  Ordnance pamphlets and S. C. A.
- (4) Adjustment of sight standard.
  Paragraphs 218 to 220, D. R. C. A.
- (5) Setting of recoil and buffer valve.
  Ordnance pamphlets.
- (6) Care and adjustment of the gas check pad.
  Paragraphs 456 and 457, D. R. C. A., and "Gunners' Instruction."
- (7) Adjustment of elevating gear.
  Ordnance pamphlets and S. C. A.
- (8) Adjustment of grease cups.
  Paragraph 444, D. R. C. A., and "Gunners' Instruction."
- (9) Care and test of firing mechanism.
  "Gunners' Instruction."
- (10) Care and preservation, including care of hand counterweights, oiling, and painting.
  Chapter XXIV, D. R. C. A.

(*c*) **Powders, Projectiles, Fuses, and Primers.**
  (1) Blending powder and preparation of powder charges.
    S. C. A. and C. A. I. O.
  (2) Filling and fusing projectiles.
    Ordnance pamphlets.
  (3) Painting projectiles.
    Ordnance pamphlets and "Gunners' Instruction."

(*d*) **Preparation for Service or Subcaliber Practice.**
  Chapter XVI, D. R. C. A. and C. A. M.

(*e*) **Service of the Piece.**
  (1) Duties of each member of the gun section under all conditions.
    D. R. C. A.

(*f*) **Precautions for Safety at the Battery.**
  Chapter XVI, D. R. C. A. and C. A. M.

(*g*) **Pointing.**
  (1) Methods of pointing and pointing tests.
    Paragraphs 223 to 227, D. R. C. A.
  (2) The telescopic sight (the quadrant for mortars).
    Paragraphs 396 and 397, D. R. C. A., and "Gunners' Instruction."
  (3) Emergency system and salvo points.
    Paragraphs 74, 86, 92, 761 to 763, D. R. C. A.
  (4) Bore sighting and orientation.
    Paragraphs 218 to 222, D. R. C. A.

(*h*) **Regulations Governing Service and Subcaliber Practice So Far as They Affect the Service at the Emplacements.**
  Chapter XV., D. R. C. A.

(*i*) **Mounting and Dismounting Guns and Carriages.**
  Ordnance pamphlets.

(*j*) **Characteristic Features of the Several Classes of Warships, General Knowledge of Local Shipping, of Channels Leading to the Harbor, and of Ranges to Prominent Fixed Objects in the Field of Fire of the Battery.**
  "Gunners' Instruction" and local harbor chart.

GUN COMMANDER AND GUN POINTER EXAMINATION QUESTIONS.

(*a*) Definitions.

Define: battery; caliber; gun (or pit) commander; gun pointer; charge; salvo; loading platform; angle of departure; angle of fall; azimuth of a point; azimuth difference; danger space; directing point; drift; deviation; range difference; rim base; fillet; reference number; predicted point; gun difference; line of impact; superior slope; aiming; axis of bore; blending; bore; bourrelet; corrected range; deflection; laying; counter-recoil buffer; fuse; racer; set-forward point; datum point. (D. R. C. A., Chapter XXVI.)

(*b*) Gun and Carriage.

On what does the racer turn, and how is this part cleaned and lubricated? How are traversing rollers inspected and cleaned? **(31.)**

Name the parts of the breech mechanism, and describe the operation of closing breech. **(26, 27, 28, 31, and G. I.)**

What is used in stuffing boxes, and how are they unpacked, packed, and adjusted? **(39.)**

Explain a method of cleaning recoil cylinders at your battery. **(36.)** Give nomenclature and function of important parts of carriage.

How is the quadrant elevation device (gun or mortar) adjusted?

What is the use of the clinometer, and how is it tested?

Explain how the base ring is tested for level, and how the corrections are applied therefor. **(33.)**

Explain how the sight standard is adjusted.

Describe the operation of bore sighting a gun or mortar.

Describe a method of orienting at your battery.

Explain a method of adjusting gun and sight to proper relation in azimuth. What is this adjustment called? **(32.)**

What is the function of the equalizing pipe, and what may be done in case of injury to it?

If a mortar does not go fully in battery on counter-recoil, what is done?

Explain the object and action of the throttling and buffer valves, and how the proper setting is determined; the action of the counter-recoil buffers; how the energy of recoil is taken up; what to do if the gun does not go fully into battery, or rebounds; and, briefly, the action of the carriage when the gun is fired. **(38.)**

Explain how the gas check pad is treated and adjusted. What is it made of? **(26.)**

How and when is the breech mechanism dismantled? **(27.)**

What device prevents the shock of discharge from injuring the elevating gear, and how is it adjusted? **(34.)**

Explain how to fill and adjust a grease cup. **(37.)**

Explain how the firing mechanism is attached and tested for safety. Name and describe function of parts. **(29, 119.)**

Under "Care of Carriage" mention the parts to which special care should be given, and the care given to each.

Name the oils furnished and the purpose of each. **(40.)**

After firing, how are the following cleaned: bore; breechblock, subcaliber tube, bore after subcaliber practice? **(103, 108.)**

(*c*) Powders, Projectiles, Fuses, and Primers.

How are drill primers loaded? how treated after firing?

Explain how to blend powder and remake charges.

Describe the shovel and cycle method of blending. Why is powder blended? What is compound blending? **(20).**

With what are A. P. and D. P. shell filled? Explain briefly the method of filling and fusing them. Object of base cover? (23.)

How are the projectiles marked so as to indicate: the metal of which made; the bursting charge; whether or not filled and fused? What is the base cover for? (22.)

Explain why a combination primer can not be fired by electricity after it has failed by lanyard. (18.)

Trace out on your carriage the electric firing circuit, the parts it goes through, and where it is broken. (31.)

(*d*) Preparation for Service and Subcaliber Practice.

How is the bore prepared for firing, and why?

What treatment is given projectiles for target practice? (104.)

Explain how to adjust the subcaliber tube. What is its caliber? (101, 22.)

What preparations are made for service and subcaliber practice? (100-108.)

Considering target practice, when should the breechblock be dismantled, and why? (103, 108.)

(*e*) Service of the Piece.

Give the manning table for a gun or mortar section.

Tabulate the duties of each member of the gun or mortar detachment at the commands: "Details Posts"; "Examine Gun"; "Load"; "Cease Firing."

What is done at the command "Relay"?

What are the duties of the gun commander as regards the range at which the gun is fired? (G. I.)

Show by a diagram how the time-range board is used. (77.)

When is the primer inserted and removed, and lanyard hooked? (119.) How can you tell the three different primers?

(*f*) Precautions for Safety at the Battery.

Explain all safety precautions attended to by the gun or pit commander.

What is done in case of misfire (1) by lanyard, and (2) by electricity?

During service practice, a piece is loaded and ready, when the command "Cease Firing" is given; what safety precautions are taken?

What safety precautions are necessary in blending powder?

What is done to protect the ear-drums from injury? (119.)

(*g*) Pointing.

Explain the pointing test (prediction test for mortars). (10.)

Describe the telescopic sight (or quadrant) at your battery, how it is applied to the gun carriage, and its adjustments and use.

Give the methods of pointing; define and explain each, and

A target is moving across the field of fire from right to left at a range of 8,000 yards; a shot fired with a deflection of 2.70 strikes 50 yards to the right of the target; how may the deflection correction be determined on the sight for the next shot, and what should the deflection setting be for the second shot? (112, 121.)

Describe the emergency system, and how it is used. (**63, 100.**)

What are salvo points, and how are they used? (**64.**)

(*h*) **Regulations Governing Service and Subcaliber Practice So Far as They Affect the Service at the Emplacements.**

At service practice, what are the requirements relative to the bringing of projectiles and powder charges to the platform?

Explain how the projectile and powder are inserted in the gun. (**82, 104, 119.**)

What arm signals are used at the battery? (G. I.)

(*i*) **Mounting and Dismounting Guns and Carriages.**

How often should a mortar be dismounted?

Briefly describe a method of removing springs from mortar carriages.

Explain how to remove piston and rod from a gun or mortar carriage. (**35, 36.**)

(*j*) **Characteristic Features of the Several Classes of Warships, etc.**

At a range of 10,000 yards, how may a typical cruiser be distinguished from a typical battleship?

Give the characteristic and distinguishing features of the following types: Dreadnought; battleship; battle cruiser; cruiser (armored and protected); destroyer; gun boat; monitor; scout. Note in each case approximate speed, draught, general appearance, armament, and armor protection. (**99.**)

Give names and characteristics of three commercial steamers plying in harbor.

Give range and azimuth from the battery to three prominent points.

PLOTTER.

(*a*) **Definitions, D. R. C. A.**

(*b*) **Position Finding System.**

(1) Detailed knowledge of system employed at the battery.
Chapter V, D. R. C. A.

(2) Indication and identification of targets.
Chapter V, D. R. C. A.

(3) Duties of each member of the range section under all conditions.
Chapter V, D. R. C. A.

(4) Emergency system and salvo points.

(*c*) **Position Finding Apparatus.**

(1) Detailed knowledge of adjustments and use of all position finding apparatus used in the plotting room.
Chapter XXIII, D. R. C. A., and C. A. M.

(*d*) **Elementary Gunnery.**

(1) Explanation of the several corrections to be applied to the observed range to obtain the corrected range.
Chapter XXIII, D. R. C. A., and S. C. A.

(2) Effect on the flight of the projectile of variations in the density of the air; the direction and velocity of the wind.
S. C. A. and paragraphs 381 and 401, D. R. C. A.

(3) Use of trial shots and application of data obtained from them (problem).

(*e*) **Preparation of Target Practice Records.**

PLOTTER EXAMINATION QUESTIONS.

(*a*) Definitions, D. R. C. A.

Define: plotter; **predicted point**; **set-forward point**; base end station; **base line**; datum point; orientation table; danger space; **deflection**; gun difference; range difference; travel of target; azimuth of a point; fire control installation; observing interval; plotting board; **reference number**; time-azimuth device; time-range board; tracking; directing point; displacement of a point; drift; muzzle velocity; communications; corrected range; range deviation; location of target; observing interval; **orientation**; **deviation**; **targ**; **coupler.**

How are different stations designated?

Give the conventional signs and abbreviations for fire control stations.

(*b*) Position Finding System.

What does the chief of range section do at the commands "Fall In"; "Call Rolls"; "Report"? How does he post his section? What does he do before reporting, and to whom does he report?

What is the post of the range section when the company is formed? (78.)

Prepare a manning table for the range section, and name the instrument used by each when tracking by horizontal base. (7, 44, 55, 56, 63.)

Enumerate and describe the various systems of position finding. (63.)

Give the manning party for B. C. and observing stations and plotting room. (7.)

Give commands for indicating a target, and explain each.

Describe the indication and identification of a target under the following headings: (1) What information does the B. C. send the plotter when the F. C. indicates a target by azimuth and range of a predicted point relocated for the B. C. station? (2) What lines of communication does he use? (3) What action is taken in the plotting room to complete the identification? (4) After the target has been described by the observers, what further identification can be made with the assistance of the plotter? **(48.)**

Give in detail the duties of each member of the range section when tracking with the horizontal base (practical demonstration in plotting room).

How does the plotter determine the plotted (observed), predicted, and set-forward points, and how often are these points plotted?

Describe in detail how the corrected range (corrected elevation for mortars) is determined; how it is transmitted, and what channels it goes through; give same information regarding deflection or corrected azimuth.

Explain the mechanical operation involved in changing from horizontal to vertical base.

What is the name of the point for which elevation or range is determined? Explain how it is located, name the other necessary points, and explain how they are located.

Describe Case III for guns.

What two kinds of travel are used, and how is each obtained and used?

What predicting and observing intervals are used for mortars, and for guns, Cases II and III? **(9, 55, 56.)**

What is done if the time-interval bells fail to work? **(57, Note.)**

When and how is the emergency system used?

Describe briefly the features of the emergency system as regards location of station; kind of instrument used; lines of communication, and manning party. **(7, 44, 63.)**

What is a salvo point, and how is it used? **(64.)**

What reports are made throughout the range section when manning stations? Give words used. (81.)

(*c*) Position Finding Apparatus.

Give a list of position finding apparatus in your plotting room. **(44.)** Same for all electrical apparatus, and their functions.

Describe the various steps in orienting and adjusting the plotting board and testing its accuracy (practical demonstration). (52.)

What changes in the plotting room apparatus are necessary in order to prepare them for subcaliber practice? (100.)

Describe the adjustment, test for accuracy, and operation of the range board. (67.)

Demonstrate the use of the following: **wind component indicator; prediction scale; set-forward ruler; deflection board.**

Explain how the deflection board is tested for accuracy. (45, 46, 65, 66, 70, 72.)

For what purpose is the powder chart used? **(42.)**

Describe the time-interval system; where the different components are located, and the instructions for its care and adjustment. **(76.)**

Demonstrate how a telephone station is opened, tested, and closed.

Upon closing station, what should be done to the telephone?

Enumerate the principles in the use of the telephone.

Give the operator's test of telephones.

Explain how telephone operators are selected.

Show how to send range and azimuth over a telephone.

What are the principal troubles occurring in telephones, and how are they determined? **(71.)**

(*d*) Elementary Gunnery.

What corrections for range are made on the range board?

Will a condition of atmosphere denser than normal cause a projectile to fall beyond or short of a target?

If the powder gives a velocity higher than normal, will the projectile fall beyond or short of the target? **(13, 67, 111.)**

Explain the object of trial shots, and how the data obtained from them is used.

Explain the method of plotting trial shots.

If the trial shots fell 200 yards over, explain what correction is made and how, before firing record shots.

The range of the aiming point for trial shots was 9,000 yards; the three splashes fell 8,910, 8,990, and 9,050. Was the muzzle velocity assumed too great or too small? Demonstrate how to find the correct velocity. (14, 67, 111.)

Explain how to make range and deflection corrections at your battery.

If the wind has an azimuth of 180°, velocity of 10 m. p. h., and the gun is laid on a target whose azimuth is 180°, what effect will the wind have on the range and deflection? The wind reference number set on the deflection board is 40; will the wind cause the projectile to move to the right or to the left? **(14, 112, 113.)**

(*e*) Preparation of Target Practice Reports.

What records are kept in the stations during target practice?

What is done with the plot immediately after practice, and what becomes of it? **(114, 122.)**

What is the approximate size of the hypothetical targets, and what do they represent? **(115.)**

Draw a diagram showing how splashes are plotted for the determination of hits.

What constitutes a hit, and how are they determined?

How is the position of target on plot determined? **(114, 117, 123.)**

OBSERVER (FIRST OR SECOND CLASS).

(*a*) **Definitions, D. R. C. A.**

(*b*) **Position finding system.**

- (1) Detailed description of that in use at the battery.
  Chapter V, D. R. C. A.
- (2) Indication and identification of targets.
  Chapter V, D. R. C. A.
- (3) Emergency system and salvo points.
  Paragraphs 74, 86, 92, 761 to 763, D. R. C. A.

(*c*) **Position Finding Apparatus.**

- (1) Detailed knowledge of adjustment and use of all observing instruments and range finders in use at the battery.
  Chapter XXIII, D. R. C. A., and C. A. M.
- (2) Use of the telephone.
  Paragraphs 367 to 379, D. R. C. A., "Gunners' Instruction," and C. A. M.

(*d*) **Characteristic Features of the Several Classes of Warships, General Knowledge of Local Shipping, of Channels Leading to the Harbor, and of Ranges to Prominent Fixed Objects in the Field of Fire of the Battery.**
"Gunners' Instruction" and local harbor chart.

OBSERVERS' EXAMINATION QUESTIONS.

(*a*) Definitions, D. R. C. A.

Define the following: angle of position (site or depression); **azimuth of a point**; **base line**; depression position-finder; field of fire; firing interval; identification of target; indication of target; relocation of a target; predicted point; danger space; **harbor chart**; **emergency station**; **orientation**; **base-end station**; **position finder**; time-range board; **datum point**; material target; range; salve point; tracking; azimuth difference; communications; directing point; field of fire; range of a shot; **horizontal base system**; **corrected range.**

Give the conventional signs and abbreviations for the stations of a battery; also for fort and fire command stations, and for muzzle velocity.

(*b*) Position Finding System.

Enumerate and describe the various systems of position finding. (63.)

Draw a diagram showing the following: B′, B″, directing-point, and target.

What data should be posted in observing stations?

With whom is the observer in direct telephone communication?

With whom is the reader in direct telephone communication? (44.)

Give the manning party for the B. C. station, observing station, and plotting room.

Describe how the data for firing is determined by horizontal base; also vertical base. **(55, 56.)**

In case the T. I. bell goes out, what is done? Give commands.

What are the qualifications of an observer? **what is he responsible for? what reports does he make, and to whom? (5, 57.)**

Give in detail the duties of an observer using a D. P. F. during the firing of trial shots. **(111.)**

Give in detail the duties of an observer and reader using a D. P. F. in following a target. Which of the cross wires is the most important? which in horizontal base? Explain when the traversing of instrument is stopped in vertical base; in horizontal base.

Act as an observer and reader tracking target, both with D. P. F. and azimuth instrument. (57.)

Demonstrate how a station is opened, reported, and closed.

To whom do base-end stations report on manning station? what words are used? (71, 81.)

Give in full the commands of the B. C., and answers of observers, in indicating, identifying, and tracking a target with horizontal base; same for vertical base, auxiliary base, and emergency system.

How can the battery commander ascertain if the observers are on the right target?

When should the battery commander designate a point of observation? If no point is indicated, what point is used?

If an observer receives a message, "Azimuth 243, range 8120," what is done by him, and what additional message does he expect?

What is the difference between "indication" and "identification" of targets?

Show graphically ship No. 3 of four ships in line entering harbor; same when in column. (48.)

In assigning a target, what lines of communication are used? In tracking, what lines are used? State who are on the various lines. **(44.)**

Describe briefly the features of the various emergency systems as regards location, apparatus, lines of communication, and manning parties. When and how is it used? What are salvo points, and how are they used? **(63, 44, 7.)**

(*c*) Position Finding Apparatus.

What instruments are required in the B. C., B′, and B″ stations. **(44.)** Name other apparatus in station and state function of each.

What is a coincidence range finder? Discuss system. (62, 63.)

Name the principal parts of a telescope. How is it cared for?

Explain how to focus a telescope.

Describe how to adjust the eyepiece of a telescope.

What causes parallax, and how is it eliminated?

If a telescope is focussed for one person, what changes are necessary if the range changes or if another observer is selected, and why?

Explain how to level an instrument which has three leveling screws; same for four leveling screws. **(8, 57.)**

Set up, adjust, and orient an azimuth instrument on tripod mount (practical demonstration if instrument is available). (61.)

Describe briefly the illuminating system in an observing station and an azimuth instrument.

What is back-lash, and how is it eliminated? **(57, 61.)**

Explain how to orient and adjust a D. P. F. (practical demonstration), using three datum points. (57, 59, 60.)

What tests of telephones are made on opening station?

What care should be taken of a telephone on closing station?

Give the rules for sending and receiving messages and data.

How can an operator tell when the electric circuit of his telephone is all right? Give nomenclature and function of parts.

What are the principal troubles in telephones? Explain how to locate and determine each. **(71.)**

(*d*) Characteristic Features of the Several Classes of Warships, Etc.

How could you, at 10,000 yards, using a telescope, distinguish a battleship, scout cruiser, submarine, armored cruiser, destroyer, dreadnought?

Give the characteristics and distinguishing features of the following types: Dreadnought; battleship; battle cruiser; cruiser (armored and protected); destroyer; gun boat; monitor; scout. Note in each case approximate speed, draught, general appearance, armament, and armor protection. **(99.)**

Give names and characteristics of three commercial steamers plying in harbor.

Give range and azimuth to three prominent objects.

Describe and name the subareas and channels of your harbor. Give ranges to all prominent points.

CHAPTER XIV.

DRILL REGULATIONS, C. A., 1914—QUESTIONS.

(Numbers preceding questions refer to paragraphs of D. R. C. A.)

CHAPTER I.

1. What two forces are used in the defense of a coast line?

2. What do the land and naval forces include? State the functions of each.

3. What, in detail, are the military preparations made by land forces for the defense of the coast line?

4. Describe the two general classes of armament used in coast forts.

5. How is the fixed armament classified?

6. Of what does the major armament consist? State its general use, the kinds of fire used, and the general use of shot and shell.

7. Of what does the intermediate armament consist? State its general use.

8. Of what does the minor armament consist? State its general use.

9. Of what does the movable armament consist? State its general use.

10. Of what does the mine defense consist?

11. How is the service of security, in coast defense, allied to the service of information, and how are they accomplished?

12. What are the units of the tactical chain of coast artillery command? Show by diagram how they are interrelated.

13. Of what does a battery command consist? Who is its commander?

14. Of what does a fire command consist? Who is its commander? How are batteries grouped to form a fire command?

15. Of what does a mine command consist? Who is its commander?

16. Of what does a support command consist? Who is its commander?

17. Of what does a fort command consist? Who is its commander?

18. Of what does a coast defense command consist? Who is its commander?

CHAPTER II.

19. What is the smallest administrative unit in the Coast Artillery, and what determines its size?

20. How are Coast Artillery companies assigned?

21. What determines the assignment of companies to batteries?

22. How is a gun company divided and subdivided?

23. How is a mortar company divided and subdivided?

24. How is a mine company divided and subdivided? What other assignments and subdivisions of sections are made?

25. Who is the commander of the section, and what are his responsibilities?

26. What manning tables are made out, and where are they posted?

27. What units furnish the personnel of the several manning tables?

28. Who are responsible for the training of the fort and fire command details?

29. Describe the manning table of a company. Where is it posted?

30. Draw a diagram showing the relations of the officers of a fort command.

31. How are coast defense and fort commanders assigned?

32. How are fire and mine commanders and staff officers asisgned? What governs the assignment of fire commanders?

33. What governs the selection of communication officers?

34. How are company officers of a mine command assigned?

35. How are company officers of a gun or mortar company assigned?

36. What influences the assignment of officers at a battery?

CHAPTER III.

37. State in detail how to form a company.

38. State in detail how an inspection (artillery) in ranks is conducted.

39. Explain how to march the company to the battery.

40. Explain how to post the sections.

41. Explain how to dismiss the sections.

42. State in detail how to form the company as infantry.

CHAPTER IV.

43. What daily record does a battery commander keep?

44. For what is the battery commander responsible?

45. What is necessary to keep a battery properly supplied at all times?

46. What are the regulations governing the modification of the drill?

47. How may temporary changes in a battery fire control installation be made?

48. How may permanent changes in fire control installations be made?

49. How may a new device at a battery be authorized?

50. How are range sections, telephone operators, and details

for fort and fire command stations kept in training during the entire year?

51. Who accompanies the fire commander in his inspection of the battery?

52. In drill and action, how is the fire direction of the various units exercised? Explain BATTERY COMMANDER'S ACTION.

53. When may the battery commander leave his station, and what is the procedure required?

54. What is done when an element of the position finding system goes out?

55. What is done to prepare the battery in the event that all communications go out?

56. State the emergency conditions under which battery drill should be conducted.

57. What are the responsibilities of the range officer?

58. What are the duties of the range officer before drill, practice, or action?

59. What report does the range officer make on manning station?

60. What does the range officer do at the conclusion of drill?

61. How are observers selected, and what are their responsibilities?

62-63. What tests are given observers operating the various instruments?

64. What is the plotter responsible for?

65. What is the emplacement officer responsible for?

66. What are the duties of the emplacement officer before drill, practice, and action?

67. What report does the emplacement officer make when manning battery?

68. What does the emplacement officer do at the conclusion of drill?

69. Who is in command of a gun emplacement or mortar pit, and what are his responsibilities?

70. What, in detail, are his duties and reports made when manning the battery?

71. What does he do at the close of drill.

72. What is the assignment for a gun pointer, what are his duties, and what test is given him?

73. What is the assignment for a mechanic, and what are his duties?

CHAPTER V.

74. Describe the systems of range and position finding, and enumerate the equipment required.

75. What system of fire direction may be used by batteries of intermediate armament?

76. Give the manning parties of a gun battery, B. C. station, plotting room, and observing station.

77. Give commands for indicating a target to the battery, and explain what is done at each command.

78. Give several examples of typical commands of the battery commander.

79. What observing and aiming points are used, and how and when are they designated?

80. Explain in detail the duties of each member of the range section when tracking with horizontal base. What may be done to hasten the data?

80A. What different methods may be used to obtain angular travel?

80B. What may be substituted for the time-range board, and how is the range drum set?

81. Explain in detail the duties of each member of the range section when tracking on vertical base. What commands may be given to discontinue tracking?

82. What should be done to insure efficiency in a fire control system?

83. What is done to provide for the T. I. bell going out?

84. Explain the duties of the range section when using the coincidence range finder.

85. When is the coincidence range finder used as an emergency instrument?

86. What additional systems of range finding should batteries have?

87. Give the manning parties of a mortar battery, B. C. station, plotting room, and observing station.

88. Give commands for indicating a target to the battery, and explain what is done at each command.

89-90. Explain in detail the duties of each member of the range section when tracking with horizontal base.

91. What are the duties of the azimuth keeper?

92. Explain the duties of the manning parties when operating vertical base or coincedence range finding and emergency systems.

CHAPTER VI.

93. What are the manning parties for a B. C. station and spotting station (minor armament)?

94. What are the duties of each member of these parties on manning station?

95. How does the B. C. indicate a target to his battery?

96. What command for tracking is given, and what is done at the command?

97. How is the angular travel and deflection obtained?

98. Explain how to range from one gun, giving commands.

Google

99-101. Describe the methods of sheaf ranging, and give commands for conducting same.

102. Explain how to fight a battery when the position finding system goes out.

103. Where should the spotting station be located?

104. Where is a desirable location for a spotting station for night work?

105. What system would be used at night under favorable and unfavorable conditions?

106. What kind of ammunition is used at night to assist in range finding?

107. When is sheaf ranging preferred in day and night firing?

108. What should be done in case a permanent installation is not provided?

109. What range finding equipment is necessary in the complete equipment of data, and what is done if it has not been furnished?

CHAPTER VII.

110. What is the strength of a pit section, and how is it subdivided?

111. Of what does a mortar detachment consist?

112. Of what does an ammunition detachment consist?

113. Of what does a reserve detachment consist?

114. Explain how to post the pit section, and give commands therefor.

115. Explain how to call off, and give command therefor.

116. Explain how to load and fire, and give commands therefor.

117. What is done at the command CEASE FIRING?

118. What are the duties of the emplacement officer during drill?

119. Who assumes the duties of the emplacement officer in his absence?

120. Prepare a table showing the duties of each member of a mortar detachment for the different commands, DETAILS POSTS; LOAD; RELAY; CEASE FIRING.

121. Show by diagram the cover posts at the command TAKE COVER.

122. What determines the cover post of the detachment?

123. What determines the cover post of No. 6?

124. What gait is habitually used by cannoneers?

125. What is the habitual position of the mortar when the command LOAD or COMMENCE FIRING is given?

126. What two systems of firing the piece are employed, and how are they used? Which is the preferred method?

127. What are the duties and responsibilities of the chief of ammunition before and during drill?

CHAPTER VIII.

128. What is the strength of a 12- or 14-inch gun section, and how is it subdivided?

129. Of what does a gun detachment consist? How is it subdivided?

130. Of what does an ammunition detachment consist? How is it subdivided?

131. Of what does a reserve detachment consist? How is it subdivided?

132. Explain how to post the gun section, and give commands.

133. Explain how to call off, and give commands.

134. Explain how to load and fire, and give commands. What is done when the rounds ordered have been fired? Give commands.

135. When dummy ammunition is used, what is done at the command CEASE FIRING?

136. Prepare a table showing the duties of each member of a 12-inch gun detachment at drill for the different commands, DETAILS POSTS; EXAMINE GUN; LOAD; CEASE FIRING.

137. What model of breech mechanism is the drill prepared for, and what changes in the drill are necessary when the gun has an 1888 breech mechanism?

138. Explain how to open breech, Model 1888 mechanism.

139. Explain how to close breech, Model 1888 mechanism.

140. Explain how to open breech, Model 1895 mechanism.

141. Explain how to close breech, Model 1895 mechanism.

142. What is done to prevent the lanyard fouling the breech mechanism, Model 1895?

143. What adjustments of shot trucks are necessary before drill or action?

144. What is done if the gun fails to go fully in battery? What should be done beforehand to obviate this?

145. Explain how to retract the gun by hand.

146. Explain how to retract the gun by electric power.

147. What is the object and operation of the friction brake?

CHAPTER IX.

148. What is the strength of a 8- or 10-inch gun section, and how is it subdivided?

149. Of what does a gun detachment consist? How is it subdivided?

150. Of what does an ammunition detachment consist? How is it subdivided?

151. Of what does a reserve detachment consist? How is it subdivided?

152. Explain how to post the gun section, and give commands.

153. Explain how to call off, and give commands.

154. Explain how to load and fire, and give commands. What is done when the rounds ordered have been fired? Give commands.

155. When dummy ammunition is used, what is done at the command CEASE FIRING?

156. Prepare a table showing the duties of each member of a 10-inch gun detachment at drill for the different commands, DETAILS POSTS; EXAMINE GUN; LOAD; CEASE FIRING.

157. What prescribed drill is generally followed for the 8- and 10-inch D. C. gun battery, and what modifications are necessary?

CHAPTER X.

158. What is the strength of a 6-inch gun section, and how is it subdivided?

159. Of what does a gun detachment consist, and how is it subdivided?

160. Of what does an ammunition detachment consist, and how is it subdivided?

161. Of what does a reserve detachment consist, and how is it subdivided?

162. Explain how to post the gun section, and give commands.

163. Explain how to call off, and give commands.

164. Explain how to load and fire, and give commands. What is done when the rounds have been ordered fired? Give commands.

165. When dummy ammunition is used, what is done at the command CEASE FIRING?

166. Prepare a table showing the duties of each member of a 12-inch gun detachment at drill for the different commands, DETAILS POSTS; EXAMINE GUN; LOAD; CEASE FIRING.

167. Explain how to retract the gun.

CHAPTER XI.

168. What is the strength of a 12-inch (B. C.) gun section, and how is it subdivided?

169. Of what does a gun detachment consist, and how is it subdivided?

170. Of what does an ammunition detachment consist, and how is it subdivided?

171. Of what does a reserve detachment consist, and how is it subdivided?

172. Explain how to post the gun section, and give commands.

173. Explain how to call off, and give commands.

174. Explain how to load and fire, and give commands. What is done when the rounds ordered have been fired? Give commands.

175. When dummy ammunition is used, what is done at the command CEASE FIRING?

176. Prepare a table showing the duties of each member of a 12-inch (B. C.) gun detachment at drill for the different commands, DETAILS POSTS; EXAMINE GUN; LOAD; CEASE FIRING.

177. What should be the position of the gun when the breech is opened or being opened?

178. Explain how to open the breech (Model 1888 mechanism).

179. Explain how to close the breech (Model 1888 mechanism).

CHAPTER XII.

180. What prescribed drill is generally followed for the 8- and 10-inch B. C., and what modifications are necessary?

CHAPTER XIII.

181. What is the strength of a 5- or 6-inch gun section, and how is it subdivided?

182. Of what does a gun detachment consist, and how is it subdivided?

183. Of what does an ammunition detachment consist, and how is it subdivided?

184. Of what does a reserve detachment consist, and how is it subdivided?

185. Explain how to post the gun section, and give commands.

186. Explain how to call off, and give commands.

187. Explain how to load and fire, and give commands. What is done when the rounds ordered have been fired? Give commands.

188. When dummy ammunition is used, what is done at the command CEASE FIRING?

189. Prepare a table showing the duties of each member of a 5-inch gun detachment at drill for the different commands, DETAILS POSTS; EXAMINE GUN; LOAD; CEASE FIRING.

CHAPTER XIV.

190. What is the strength of a 3-, 4-, or 4.7-inch gun section, and how is it subdivided?

191. Of what does a gun detachment consist, and how is it subdivided?

192. Of what does an ammunition detachment consist, and how is it subdivided?

193. Of what does the reserve detachment consist?

194. Explain how to post the gun section, and give commands.

195. Explain how to call off, and give commands.

196. What method of firing is used?

197. Prepare a table showing the duties of each member of a 3-inch gun detachment at drill for the different commands, DETAILS POSTS; EXAMINE GUN; LOAD; CEASE FIRING.

198. What is done to insure the cartridge cases fitting the chamber?

199. What is done if a cartridge jams on insertion?

200. What is done if a cartridge can not be extracted easily?

201. How is the drill modified to care for a masking parapet mount?

202. What modification of drill is authorized for a 4.7-inch gun?

CHAPTER XV.

203. What is done in drill to insure team work? What gait is habitually used?

204. How should commands be given?

205. How is actual loading and firing simulated?

206. What is done at the command TAKE COVER?

207. What kind of primers should be used at drill?

208. Explain how and when a primer is inserted.

209. What force is necessary to fire a friction primer?

210. How is the lanyard pulled, and from what position?

211. What should be done with primers that fail to fire?

212. What should be done to prevent premature firing by lanyard?

213. Give the arm signals for ELEVATE; DEPRESS; RIGHT; LEFT; CLAMP; HALT; STAND FAST; TAKE COVER; READY. What do they signify?

214. In what other way may signals be given?

215. Describe in detail how the projectile is seated.

216. Describe the powder serving tray.

217. Describe the use of the powder serving tray.

218. Explain the adjustment of the sight standard.

219. Explain the adjustment of the azimuth indices at a gun battery.

220. Explain gun differences, and how to correct therefor.

221. Explain the method of orienting mortars.

222. What test should be given quadrants, and how often?

223. Explain the methods of pointing, and state when the piece is fired.

224. Explain the pointing test for gun batteries, and give examples.

225. How is the excellence of a gun pointer's work determined?

226. What training of the gun pointer is necessary in a disappearing carriage?

227. Explain the prediction test for mortars, and give examples.

CHAPTER XVI.

228. From where do the regulations for subcaliber and service practice emanate?

229. What is the object of subcaliber practice, and how is it held to best accomplish the desired results?

230. What are the responsibilities of the battery commander before service practice?

231. What treatment is given the bore and breech mechanism before practice?

232. How is the powder stored in the magazine prior to practice, and why?

233. What steps are taken to insure that powder for one caliber is not used in another caliber?

234. What is done in case a poor practice is attributable to the powder?

235. How are projectiles prepared for practice?

236. What is done immediately after the piece is fired?

237. What is done to keep the gas check seat, breechblock, and recess in order?

238. What safety precautions are taken at the breech when firing?

239. What inspection is made after the practice, and what treatment is given the bores and breechblocks?

240. What action is taken to prevent injury to the ears during firing?

241. What action is taken to insure against accident?

242-243. What is done in case of misfire?

244. What is done at the command CEASE FIRING?

245. What should a junior do who is ordered to fire when he deems it unsafe?

246-248. What instructions govern the firing of salutes, and what are the safety precautions to be observed?

CHAPTER XVII.

249. Give the manning party for a fire commander's primary and secondary stations.

250. How are fire commanders assigned to fire commands?

251. For what is the fire commander responsible?

252. Are his duties confined to tactical efficiency?

253. Where is his station, and where may he go?

254. On what does he keep the fort commander informed?

255. What are his duties during battery drill and indoor instruction?

256. What steps should be taken to secure maximum efficiency?

257. What staff officer is assigned him, and what are his duties?

258. What are the duties of the communication officer when manning station?

259. What are the duties of each member of the manning party when manning station?

260. Explain how a fire commander indicates a target to his observers and battery commanders under normal and abnormal conditions, and give typical commands.

261. What searchlights are controlled by the fire commander?

262. What is meant by "Fire commander's action" and "Battery commander's action," and when are they assumed?

263. Who determines the order (or kind) of fire of batteries?

264. Give the several commands for indicating a target to the batteries, and explain what is done at each command, and name the orders (or kinds) of fire.

265. Give several type commands of fire commanders in assigning targets.

266. Give type commands when warship division may be simulated.

267. What, in general, governs the kinds of commands to be used?

268. Explain what the following commands signify: CEASE FIRING; CHANGE TARGET; CLOSE STATION.

CHAPTER XVIII.

269. Give the manning parties for a mine commander's primary and secondary stations.

270. For what is the mine commander responsible?

271. Are his duties confined to tactical efficiency?

272. Where is his station, and where may he go?

273. Who is responsible that the proper equipment is on hand?

274. Who designates the property officer, and what are his duties? How is mine property obtained and cared for?

275. Who directs the fire of several batteries of a mine command, and what general method is used?

276. Give the manning party for a fort commander's station.

277. Of what does a fort command consist?

278. For what and to whom is a fort commander responsible?

279. How does he prepare his fort for defense and command it in action?

280. Who controls the seaward defense of a harbor when several fort commands are adjacent thereto?

281. How is the tactical station of a fort commander designated, and what steps are taken when he leaves his station?

282. How best does his command attain maximum efficiency?

283. What officers are assigned the fort commander?

284. What are the duties of the personnel officer before and during drill or action?

285. What is the matériel officer responsible for?

286. What is the procedure followed when matériel is out of order?

287. What are the duties of the matériel officer prior to drill or action?

288. What are the duties of the fort command station detail when manning station?

289. Explain how a fort commander indicates targets to his observers and fire commanders. How does he prepare his command for service?

290. How does he arrive at his "Estimate of the situation"?

291. Give commands for assigning target to all (also to one) fire commanders, and explain what is done at each command.

292. What should be done to simulate real action?

293-295. For what and to whom is the meteorological observer responsible, and what are his duties on opening station, and during drill and action?

296. What record is kept in the meteorological station?

297. For what and to whom is the tide observer responsible, and what are his duties on opening station, and during drill and action?

CHAPTER XIX.

298. Of what does a coast defense command consist?

299. How are coast defense commands, their headquarters and limits established?

300. Is the coast defense commander a tactical or administrative officer?

301. Where is his station during drill and action?

302. What is done by him to convenience the assignment of targets?

303. What are his duties during actual or threatened action?

304. What is done by him to insure tactical efficiency?

305. Over what has the coast defense commander control?

306. What is the procedure in case repairs are needed?

307. What are his responsibilities and duties relating to water transportation?

308. What are his duties concerning the inspection of artillery boats?

309. What inspections are made by masters, and who are responsible therefor?

310. What are the regulations governing the care and assignment of distribution box boats?

311. What are the regulations regarding the use of artillery boats?

312. What duties devolve on a coast defense commander with reference to vessels of war?

313. What are the duties of a coast defense adjutant?

314. What governs the assignment as artillery engineer? What is he charged with, and what inspection does he make?

315. How is engineer, signal, and mine property obtained and accounted for?

316. How is this property issued for use, and who is responsible therefor?

317. What are the regulations governing the transfer of property between forts?

318. The artillery engineer is responsible for the maintenance and operation of what?

319. How are supplies obtained for the power plants?

320. What reports are rendered on internal combustion engines?

321. What are his duties in reference to the maintenance of ordnance?

322. What enlisted men are assigned to fort matériel officers, and how are their services obtained and utilized?

323. What is the procedure to employ enlisted specialists as clerks or store keepers?

324. What is done to develop enlisted specialists?

325. How are the services of ordnance machinists obtained for matériel other than ordnance?

326. What tests are made on submarine mine cable?

327. With what is the ordnance officer charged, and what inspections does he make?

328. What action is taken to insure the proper ordnance supplies are on hand?

329. How is ordnance property issued and transferred from fort to fort?

330. Who is in charge of ordnance repair shops and the personnel therein?

331. How does the ordnance officer obtain technical assistance for his electrical equipment?

332. What are the duties and responsibilities of the coast defense quartermaster, and what inspection does he make?

333. How may the quartermaster obtain the services of the ordnance machinist?

334. What duties devolve on coast defense officers when inspections are made by visiting staff corps officers?

CHAPTER XX.

335. What is done to prepare for a coast artillery inspection?

336. What is the order in which the equipment is inspected, and who accompanies the inspector?

337. What is done as the inspector approaches and inspects a station?

338. What is done as the inspector approaches and inspects a battery?

339. What is done as the inspector approaches and inspects a gun emplacement?

340. What is done as the inspector approaches and inspects a mortar emplacement?

341. State in general what an artillery inspection should cover, and to what special attention should be given?

CHAPTER XXI.

342. What accessories are necessary for successful defense against night attack?

343. What searchlights are in the service, and what is the standard size?

344. In what two ways are searchlights classified?

345. Who controls all the searchlights over any water area?

346. What is done to the water area to convenience the tactical use of searchlights?

347. How are fort command searchlights utilized in searching?

348. How are fire command searchlights utilized in searching?

349. What are illuminating lights primarily used for, and by whom are they controlled?

350. In what two ways may an illuminating light be used in searching?

351. How is a mine light controlled?

352. What is the normal collective use of searchlights?

353. Give the manning parties of a searchlight: (1) when operated from a central plant; (2) internal combustion engine; and (3) local steam plant.

354. Who is responsible for the instruction and drill of searchlight manning parties, and where is his station during drill?

355. What are the qualifications of a watcher, and what are his duties?

356. What are the qualifications of a searchlight operator, and what should influence their assignment?

357-359. How are searchlights designated? Give all type commands, and explain each. Explain the individual use of a searchlight in searching.

360. What is the object of night drill in general?

361. What is the object of battery night drill, and how is it conducted?

362. What is the object of coast defense, fort or fire command night drill, and how is each conducted?

363. What are the regulations about a light coming on boats not provided for artillery purposes?

364. What use should be made of searchlight control drill?

CHAPTER XXII.

365. What are the different methods of communications in coast artillery?

366. What signal stations are established in coast forts?

367-372. State in detail how telephone operators are selected.

373-374. Explain how to open and test a telephone station.

375. By whom are telephones repaired?

376. Enumerate the principal troubles of telephones, and explain how to detect them.

377. Explain in detail how to send messages by telephone.

378. Give the rules to be observed in the receiving of messages.

379. Explain how the telephone is cared for, and how to close station.

CHAPTER XXIII.

380. Describe the anemometer, and explain its operation.

381. Describe the atmosphere rule, and explain its operation.

382. Explain how to set up and orient an azimuth instrument.

383. What two kinds of barometers are there? Where are barometers located, and for what are they used?

384. Describe the gun deflection board, and explain its operation.

385. Describe the mortar deflection board, and explain its operation.

386. Describe the deflection board for mine armament, and explain its operation.

387. Describe the deflection recorder's board, and explain its operation.

388. Give the principle of depression position finders.

389. Explain the adjustment for range and azimuth of the Swasey D. P. F.

390. Explain the adjustment for range and azimuth of the Lewis D. P. F.

391. Explain how to set up and adjust the gun plotting board.

392. Explain how to set up and adjust the fire commander's plotting board.

393. Explain how to set up and adjust the mortar plotting board.

394. Describe the Pratt range board, its adjustments, operation, and tests.

395. Describe the range board for minor armament, and explain its operation.

396. Describe the telescope. How is it cared for and adjusted?

397. Describe the telescopic sight, and explain its use.

398. Explain the use of the thermometer. Where is it located?

399. Describe the time-interval system.

400. Describe the time-range board, and explain its operation.

401. Describe the wind component indicator, and explain its operation.

402. Describe the wind vane, and explain its operation.

CHAPTER XXIV.

403. What responsibilities devolve on officers in the care of property?

404. Where are the instructions for the care of property obtained?

405. What is meant by "in (or out of) service"; "in (or out of) commission"?

406. Who are the responsible officers for batteries in and out of service?

407-408. What duties devolve on, and what equipment and supplies are furnished by, the Engineer Department?

409. What duties devolve on, and what equipment and supplies are furnished by, the Ordnance Department? Name the oils furnished and the use of each.

410. What supplies and equipment are furnished by the Signal Corps?

411. What supplies and equipment are furnished by the Quartermaster Department?

412. What care should be given coast defense structures and adjacent grounds?

413-414. How are drains, sumps, and water fixtures kept in working order?

415. What is done to prevent damage in cold weather?

416. What is done after rains?

417. What is done to prevent the slopes being broken down?

418. What is done to prevent damage by fire?

419. What is done to prevent damage to doors and windows during firing?

420. What is done to maintain in working order the lighting and power equipment?

421. What are the regulations governing the care and use of ammunition hoists?

422. When and how are pamphlets and ordnance material obtained?

423. Name the different kinds of oil, and state the use of each.

424. Where is the allowance of paint prescribed?

425. Describe the regulations and methods of painting guns and mortars.

426. Describe the regulations and methods of painting carriages.

427. How is paint issued and prepared?

428. Describe a method of removing paint from guns and carriages.

429-433. Describe in detail the method of marking guns and mortars.

434. Are any parts of seacoast cannon expendable?

435. What exercise is given disappearing guns in commission?

436. What exercise is given barbette guns in commission?

437. What is done to prevent rusting of the bore and exposed surfaces?

438-439. How is the bore cared for and prepared for firing?

440. What treatment is given the bore after firing?

441. What is the habitual position of guns on disappearing and barbette carriages?

442. What is the habitual position of mortars? When is the breech cover used?

443. Discuss how all parts, including oil holes, are cared for and lubricated.

444. Explain how to fill and adjust a grease cup.

445–446. State the care given recoil cylinders.

447. What material is used in stuffing boxes?

448. What exercise is given motors on gun carriages?

449. What material is used for removing rust?

450. What inspection of throttling bar bolts are required?

451. What are the regulations governing the dismounting of mortars?

452. What are the regulations governing the cleaning of recoil cylinders?

453–455. Describe how breechblocks are dismounted, dismantled, and assembled.

456. Describe the treatment given gas check pads, and the object therefor.

457. Describe the adjustment of a gas check pad.

458–459. What are the regulations governing the care of breech mechanisms?

460. What are the regulations governing the care of firing mechanisms?

461. How are projectiles piled and cared for?

462. What is done with packing boxes for projectiles?

463. Describe the method of painting projectiles.

464. Describe the method of filling and fusing projectiles.

465. Describe the treatment given dummy projectiles.

466. Describe the treatment given empty cartridge cases and primer bodies.

467. Discuss the care of telescopes.

468. When are paulins for gun carriages provided?

469. Where are the instructions on Signal Corps property found?

470–476. State in detail the duties of caretaker detachments, their size, the commander thereof, and his responsibilities.

477. What inspections are required of matériel at ungarrisoned forts?

CHAPTER XXV.

478. What inspections of powders and explosives are required?

479–480. Discuss the care and handling of explosives.

481. Who personally directs the handling of explosives?

482. Why are cases kept out of the sun's rays?

483. What implements are prescribed for opening cases, and why?

484. How are keys to magazines kept?

485. How are different explosives in a single magazine piled?

486. What record of explosives is kept?

487. What regulates the storing of different explosives together?

488-489. What ventilation of magazines is necessary?

490. How is black powder supplied and stored?

491. Are lights and matches allowed in magazines?

492. Where should loose explosives be kept?

493. Should empty cases be stored with filled cases?

494. What regulations should be posted in magazines?

495. How are commercial detonators supplied?

496-499. How are commercial detonators stored and cared for?

500. What inspection of commercial detonators is required?

501. How is dynamite supplied?

502-506. How is dynamite stored and cared for?

507. What may be stored with dynamite?

508-511. State the inspections required, the principal source of danger, and storage of dynamite.

512-513. How is Explosive "D" supplied?

514-518. How is Explosive "D" stored and caredfor?

519. What explosives may be stored with Explosive "D"?

520-522. What inspection of Explosive "D" is required?

523. How are fuses and primers supplied?

524-525. How are fuses and primers stored and cared for?

526. Should fuses and primers be stored with explosives?

527. When should fuses be disassembled?

528. What inspections of fuses and primers are required?

529. How is guncotton packed and supplied?

530-537. How is guncotton stored and cared for?

538. What treatment is given empty guncotton cases?

339. What inspection of guncotton is required?

540. What quarterly inspection of guncotton is called for?

541-545. What is dry guncotton used for, and how is it prepared and cared for?

546. What is trotol, and what is it used for?

547-549. How is trotol stored and cared for?

550. What may be stored with trotol?

551-552. What inspection of trotol is called for?

553. How are powder charges supplied?

554-556. How is smokeless powder stored and cared for?

557-558. What is done to insure that the cases are airtight?

559. What check is kept on powder by ordnance chemists?

560-565. Describe the tests given smokeless powder at forts.

566. What powder tests are given fixed ammunition?

567-568. How are powder storage cases temporarily sealed?

569-571. How are projectiles stored, handled, and cared for?

572. What inspection of projectiles is called for?

573. How are projectiles filled but not fused cared for?

574. What inspection of projectiles filled but not fused is required?

575. How is fixed ammunition stored and cared for?

576. What inspection of fixed ammunition is called for?

PARAGRAPH
Acetylene lantern 89
Adjustments—
    Center of impact to center of record target (danger space correction) 16
    Elevating friction mechanism 34
    Gas check pad 26
    Grease cups 37
    Firing mechanism 29
    Range scale and quadrant 33
    Recoil and counter recoil system 38
    Sight standard and azimuth subscale 32
    Stuffing boxes 39
    Subcaliber gun 101
Alphabet, General Service Code 87
Ammunition—Chapter III., page 33.
Ammunition allowances 104, 105
Anemometer 41
Armament, fixed and movable 3
Assignment of personnel 5
Atmosphere 13
Atmosphere slide rule 42
Attack, forms of 2
Azimuth instruments 61
Ballistics and Gunnery—Chapter II., page 11.
Barometer 43
Base ring, differences in level 33
Basic Course Questions—page 115.
Battery command and commander 4, 5
Battery Commander Course—page 130.
Battery commander's station, equipment of 44
Battery commander, commands of 93
Battery commander, reports of 81
Battery drill 82
Bore sighting 32
Breechblock, dismounting and dismantling 27, 28
Calibration 33
Camera, use of at target practice 123
Cannon, classification and description 25
Care and storage of explosives 21
Care of matériel 40
Carriages, classification and description 30, 31
Cartridge cases, care of 102
Case I., II., and III 9, 55
Center of impact 11–16
Characteristic features of warships 99

PARAGRAPH

Chief of detachment, reports of 81
Chief of section, commands of 93
Cleaning recoil cylinders 36
Clinometer 33
Coast artillery inspection 83
Coast defense 1
Coast defense command and commander 4, 5
Coincidence range finders 62
Coincidence system 63
Commands, list of 93
Communications and equipment 44
Communication officer, reports made by 81
Company commander, commands of 93
Conduct of target practice 121
Cordage, tackles, etc . . . . . 94 to 98
Corrections for trial shots 14
Counter recoil and valves 38
Curvature of earth, formulæ for 15, 117
Danger space 15, 16
Data for target practice reports 123
Datum points 57
Deflection board, gun 45
Deflection board, mortar 46
Deflection corrections 14, 112
Deflection recorder's board 47
Depression position finders 57, 61
Deviations 11
Dismantling and dismounting breechlocks 27, 28
Dismounting mortars 35
Drill and inspection . . . . . 78 to 83 and 92
Drills and Inspections—Chapter VI., page 75.
Drill primer bodies, care of 102
Drill Regulations, C. A. C., Questions on—Chapter XIV., p. 153.
Duties in plotting room 55, 56
Elevating friction mechanism 34
Emergency station, equipment for 44
Emergency system 63
Emplacement Course—page 121.
Emplacement officer 5
Emplacement officer, commands of 93
Emplacement officer, reports of 81
Errors 12
Examinations for Officers—Chapter XII., page 115.
Examinations for Rated Positions—Chapter XIII., page 142.
Explosives, care and storage of 21

PARAGRAPH
Figure of merit....118
Filling and fusing projectiles....23
Film scale, use of....123
Fire command and commander....4, 5
Fire commander, commands of....93
Fire command station, equipment of....44
Fire and Fort Commander Course—page 137.
Fire commander's plotting board....53
Fire commander, reports of....81
Fire Control Apparatus—Chapter V., page 39.
Fire control equipment in stations....44
Fire direction....48, 55, 63, 93
Firing mechanism....29
Flags, use of....86
Forms, target practice....122
Fort command and commander....4, 5
Fort commander, commands of....93
Fort command station, equipment of....44
Fuses....17
Gas check pads....26
Grease cups....37
Gun (or pit) commander....5
Gun commander, commands of....93
Gun Commander, Examination Questions—page 143.
Gun (or pit) commander, reports of....81
Gun pointer....5
Gunnery and Ballistics—Chapter II., page 11.
Guns and Carriages—Chapter IV., page 29.
Guns, general description of....25
Hits, determination of....117
Horizontal base system....63
Howitzers, general description of....25
Hydraulic jacks....98
Indication and identification of targets....48
Inspection in ranks....79
Inspection, coast artillery matériel....83
Inspection for service practice....103
Lewis Depression Position Finder, model of 1907....59
Lewis Depression Finder, Type A, model of 1898....58
Line of direction....11
Loading projectiles with explosive....23
Magazines, ventilation of....21
Manning tables and parties....6, 7
Marching maneuvers....80
Matériel officer, reports of....81

PARAGRAPH
Mechanics 7
Meteorological station, equipment of 44
Meteorological station, reports of 81
Mine command 4
Mortars, description of 25
Mortars, dismounting 35
Mortar elevation board 51
Mortar plotting board, 360° 54
Mortar range board, model of 1914 69
Muzzle velocity 111
Muzzle velocity charts, gun and mortar 49, 50
Night drill 92
Nomenclature of carriages 31
Observing station, equipment of 44
Observers 5
  Commands of 93
  Reports made by 81
  Test of 57
  Examination Questions—page 150.
Obturating and safety devices 108
Officers' Examination Questions—Chapter XII., page 115.
Oiling and painting 40
Organization and Coast Defense—Chapter I., page 5.
Organization, tactical 4
Orientation of guns and mortars 32
Orientation of position finding instruments 57–63
Packing stuffing boxes 39
Parallax 57
Penalties in target practice 120
Personnel officer, reports made by 81
Plotter 5
  Reports of 81
  Examination Questions—page 147.
Plotting room duties 55, 56
  Equipment 44
Plotting boards—
  Fire commander's 53
  Guns and mortar 52
  Mortar, 360° 54
Plotting splashes 114–117
Pointing 8, 9
Pointing and prediction tests 10
Position finding instruments 57
Position finding systems 63
Powders and powder blending 19, 20

THIS BOOK IS DUE ON THE LAST DATE
STAMPED BELOW

AN INITIAL FINE OF 25 CENTS
WILL BE ASSESSED FOR FAILURE TO RETURN
THIS BOOK ON THE DATE DUE. THE PENALTY
WILL INCREASE TO 50 CENTS ON THE FOURTH
DAY AND TO $1.00 ON THE SEVENTH DAY
OVERDUE.

NRLF

OCT 26 1932

SEP 10 1934

FEB 12 1942

FEB 18 1942 P

DEC 19 1983

REC. CIR. SEP 19 '83

SENT ON ILL

APR 25 1996

U. C. BERKELEY

YB 04267

359890

UF453
P5

UNIVERSITY OF CALIFORNIA LIBRARY